Vol. 16. No. 145. JANUARY, 1914. [Price SIXPENCE Net.

FOUNDRY TRADE JOURNAL AND PATTERN-MAKER

EDITORIAL & ADVERTISEMENT OFFICES:
165, Strand, London, W.C.

R & J DEMPSTER, LTD.

Oldham Rd., MANCHESTER.

BLOWERS

R. & J. DEMPSTER, LTD. PATENTED SPECIALITIES.

STEEL REVOLVERS (No. 3 and upwards). LEATHER CONTACT PIECES.
IMPROVED BEARINGS.

SOLE MAKERS OF

"PEHRSON'S PATENT STEEL MOULDERS' GREENSAND."

FOR LIGHT CASTINGS. SAVES DRYING IN STOVES.

Compositions for
BESSEMER, SIEMENS, AND CRUCIBLE STEEL CASTINGS, CORES, ETC.
SILICA PAINT.

GROUND GANISTER FOR ALL KINDS OF FURNACES.
SILICA CEMENT.

GANISTER SUPPLIED IN ROCK, CALCINED, OR BROKEN.

Makers of
GANISTER BRICKS and FIRECLAY GOODS of every description.
STEEL RUNNERS, STOPPERS, NOZZLES, ETC.
CRUCIBLE CLAY OF THE FINEST QUALITY.

J. & J. DYSON,

SHEFFIELD GANISTER WORKS,

Telegrams: "DYSON, STANNINGTON."
Telephone: CENTRAL 702.

SHEFFIELD.

Index to Advertisers.

Addresses, Telegraphic Addresses, and Telephone Numbers.

PAGE.	NAME.	ADDRESS.	TELEGRAPHIC ADDRESS	TELEPHONE NO.
6	Alldays & Onions, Ltd.	Birmingham	Alldays, Birmingham	28 Victoria
54	Braby, F. & Co., Ltd.	Petershill Road, Glasgow	Braby, Glasgow	—
4	Bradley, T. & I., & Sons, Ltd.	Darlaston	Bradley, Darlaston	—
	Britannia Foundry Co.	Coventry	Stoves, Coventry	251
5	British Aluminium Co., Ltd.	109, Queen Victoria Street, E.C.	Cryolite, London	4315 London Wall
11	Brinck & Hübner	Mannheim, Germany	—	—
C. iv.	Buckley & Taylor Ltd.	Castle Iron Works, Oldham	Engines, Oldham	Oldham No. 8
4	Cumming, William, & Co. Ltd.	Maryhill, Glasgow	Prudence, Glasgow	P. O. M. 25
55	Davidson & Co., Ltd.	Belfast	Sirocco, Belfast	4341 Belfast
C. ii	Dempster, R. & J., Ltd.	Oldham Road, Manchester	Scrubber, Manchester	—
3	Davies, T., & Son	West Gorton, Manchester	Tuyere, Manchester	70 Openshaw
	Derby Boiler Co., Ltd.	Derby	Welded, Derby	100 Derby
57	Durrans, Jas., & Sons	Penistone, nr. Sheffield	Durrans, Penistone	—
C. ii.	Dyson, J. & J.	Sheffield	Dyson's, Stannington	702 Sheffield
55	Elders' Collieries, Ltd.	Cardiff	Elder, Maesteg	10
12 & 58	Evans, J., & Co.	Manchester	Ladles, Manchester	2297
8	Everitt & Co.	40, Chapel Street, Liverpool	Persistent, Liverpool	1134 Central (3 lines)
59	Frodair Iron & Steel Co, Ltd.	5, Fenchurch Street, E.C.	Frodair, London	—
8	Fyfe, J. R. & Co.	Shipley, Yorks	Brick, Shipley	59 Shipley
2	Goldendale Iron Co., Ltd.	Tunstall, Stoke-on-Trent	Goldendale, Tunstall, Staffs	—
8	Hall, John, & Co (Stourbridge), Ltd.	Fire Clay Works, Stourbridge	Hall, Stourbridge	55 Stourbridge
8	Hislop, R. & G.	Paisley	Gas, Paisley	331 Paisley
9	Keith, James & Blackman, Co., Ltd.	27; Farringdon Avenue, London	James Keith, London	6194 H'lb'rn(4lines
4	King, Bros. (Stourbridge), Ltd.	Stourbridge	King Bros., Stourbridge	—
11	Kuhnle, Kopp & Kausch	Frankenthal-Pfalz, Germany	—	—
58	London Emery Works, Co., Ltd	Park, Tottenham	Naxium, London	99 Tottenham
56	Lowood, J. Grayson, & Co., Ltd.	Deepcar, nr. Sheffield	Lowood, nr. Sheffield	18 Stocksbridge
	Marshall, H. P., & Co.	Leeds	Specialty, Leeds	1909 Leeds
11	Metalline Cement Co.	112, Bath Street, Glasgow	Adhesive, Glasgow	201Y2 Douglas
7	McLain's System	710, Goldsmith Bldg, Milwaukee, U.S.A.	—	—
60	McNeil, Chas.	Kinning Park, Glasgow	McNeil, Glasgow	X 155
9	Murphy, Stedman & Co. Ltd.	180, Gray's Inn Road, London, W.C.	—	—
59	Naish & Croft	141, Whitehead Road, Aston Manor	—	—
8	National Time Recorder Co.	5, Blackfriars Road, London, S.E.	Natrecord, London	918 Hop
4	Olsen, William	Cogan Street, Hull	Wm. Olsen, Hull	Nat. 1184
	Pattern Requisites, Ltd.	24, Branstone Street, Birmingham	—	—
59	Phillips, Charles D.	Newport, Mon.	Machinery, Newport	—
C. iii	Phillips, J. W. & C. J.	23, College Hill, E.C.	Colloquial, London	10112 Central
	Piftin, Ltd.	2, Fen Court, Fenchurch Street, E.C.	Russesco, London	11230 Central
	Rapid Magnetting Machine Co., Ltd.	18, The Crescent, Birmingham	Borings, Birmingham	Central 1842
58	Rudd & Owen	Hull	Therpinene, Hull	1223 Nat.
	Samuelson & Co., Ltd.	Banbury	Samuelson, Banbury	—
1	Standard Sand Co., Ltd.	Mansfield	Standard Sand Co., Mansfield	201 Mansfield
5	Stewart, D., & Co., Ltd.	London Road Iron Works, Glasgow	Stewart, Glasgow	71 P.O. Bridgton & 3243 Bridgton (N)
C. iii.	Tilghman's Patent Sand Blast Co., Ltd.	Broadheath, nr. Manchester	Tilghmans, Altrincham	14
10	Thwaites Bros., Ltd.	Bradford	Thwaites, Bradford	3459&3460 Br'df'rd
5	Walker, I. & I.	Rotherham	—	—
60	Walton & Co.	53, Newton Street, Birmingham	"Walco," Birmingham	Central 3305
60	Whittaker, W., & Sons, Ltd.	Oldham	Whittakers Engineers, Oldham	83
11	Wilkinson, Thos., & Co., Ltd.	Middlesbrough	Blacking, Middlesbro'	419
11	Witting Bros., Ltd.	49, Cannon Street, London, E.C.	Witting, Cent., London	8776 & 8777 City

MANSFIELD MOULDING SAND.

As Shipped by us to all parts of the World, for Castings of Iron, Brass, Aluminium, &c.

WRITE STATING CLASS OF WORK TO

The Standard Sand Co., Ltd.,
Mansfield, NOTTS.

Goldendale Cylinder Pig Iron.

MAKERS:

GOLDENDALE IRON Co.,

TUNSTALL, STOKE-ON-TRENT.

Special FOR GAS AND OIL ENGINE LINERS - -

Our Mottled and White .. Cylinder Pig Irons ..

ARE

Absolutely sound and homogeneous

AND

Melt hot and Fluid.

AND

Though extremely hard will machine with ease

AND

Will Cool like Grey Iron leaving no cavity.

CONTRACTORS TO THE ADMIRALTY, COLONIAL GOVERNMENTS, AND OTHER GOVERNMENT CONTRACTORS.

Selling Agents—

WESTOBY & RAWSTRON, 224, Corn Exchange Buildings, Hanging Ditch, Manchester.

T. DAVIES & SON,

RAILWAY WORKS, WEST GORTON, MANCHESTER.

ON ADMIRALTY LIST.

Telegrams—"TUYERE, MANCHESTER. Nat. Telephone—No. 70, OPENSHAW.

Specialities

FOUNDRY CUPOLAS & LADLES

ALL TYPES AND SIZES IN STOCK OR PROGRESS.

LICENSEES and MAKERS of

Osborn's Patent Spark Arrester

FOR FOUNDRY CUPOLAS.

Efficient. Simple in Design.

Require no Attention.

Prevent Fire or Damage to Surrounding Buildings.

SAVE THE COST OF FREQUENT CLEANING OF THE ROOFS AND GUTTERS.

THOROUGHLY RELIABLE.

London Agents: Murphy, Stedman & Co., Ltd., 180, Gray's Inn Road, London, W.C.

FIRE BRICKS & CLAY

CUPOLA BRICKS.

BEST QUALITY.

LESSEES OF DELPH AND TINTERN ABBEY BLACK AND WHITE CLAY.

KING BROTHERS,

(STOURBRIDGE) Ltd.,

STOURBRIDGE.

PLUMBAGO — CRUCIBLES.

Parting Powder.

MATERIALS & REQUISITES FOR IRON & BRASS FOUNDRIES

Wm OLSEN M.B.F.A.

74, COGAN ST., HULL

CATALOGUE ON APPLICATION.

Wax Core Vent.

GLUTRIN — CORE GUM.

WILLIAM CUMMING & CO., LTD.,

FOR IRONFOUNDERS' BLACKING
PLUMBAGO
BLACK LEAD
CORE GUM
COAL DUST
ETC.

—o—

Write for Quotations.

WORKS—
Kelvinvale Mills, Maryhill, Glasgow
Sunnyside Blacking Mills, Falkirk.
Old Packet Wharf, Middlesbrough.
Albion, West Bromwich.
Whittington Blacking Mills, Nr. Chesterfield.

IRONFOUNDERS FURNISHERS

Established 1840.

Also
THE WELL-KNOWN BRANDS
"IMPERIAL"
"EUREKA"
"VULCAN"
"CROWN"

Registered Brand—
"SHALACO"

Telegraphic Address—
Prudence, Glasgow.
Cummin Blacking Mills, Camelon.
Cumming, Whittington, Chesterfield.

T. & I. BRADLEY & SONS, LTD.,

COLD BLAST PIG IRON

PIG IRON BRANDS

PART MINE.

WARM AND COLD BLAST. IXL.

ALL MINE.

A M

TO GUARANTEED ANALYSIS.

DARLASTON BLAST FURNACES,

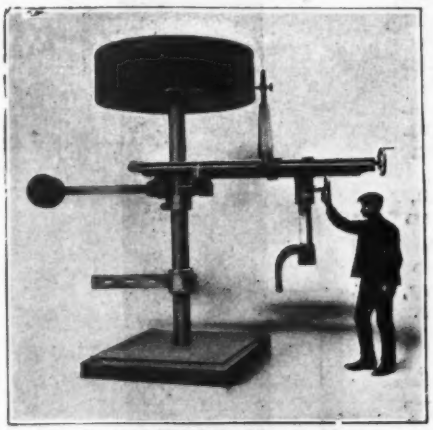
DARLASTON, SOUTH STAFFS.

66% Weight Economy.

THIS advantage of paramount importance in the case of castings in power-propelled vehicles and with jigs and numerous machine parts, is secured by the use of ALUMINIUM.

For Hints on Working see our "Foundry" Leaflet.

THE BRITISH ALUMINIUM CO., LTD., Ad. Dept, 109, Queen Victoria Street, LONDON.



Standard Wheel Moulding Machine.

ALL IRON AND STEEL FOUNDRIES

SHOULD BE EQUIPPED WITH

STEWART WHEEL MOULDING MACHINES.

Complete Satisfaction Guaranteed

* *

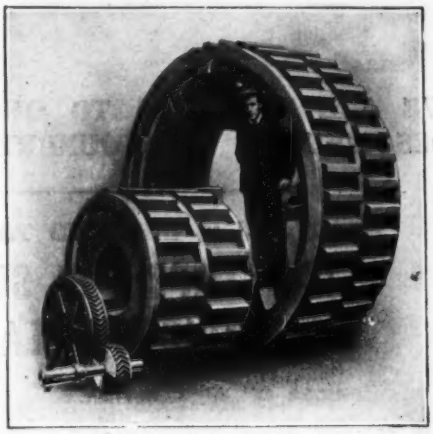
No Loose Parts Liable to be Lost.

ACCURATE. PORTABLE. CHEAP.

WRITE FOR PRICE AND PARTICULARS TO

DUNCAN STEWART & CO., LTD.

LONDON ROAD IRONWORKS, GLASGOW.



Wheels Moulded by this Machine.

WE SUPPLY **THE** LEADING FIRMS IN THE TRADE WITH

FOUNDRY BLACKINGS

OF ALL KINDS,

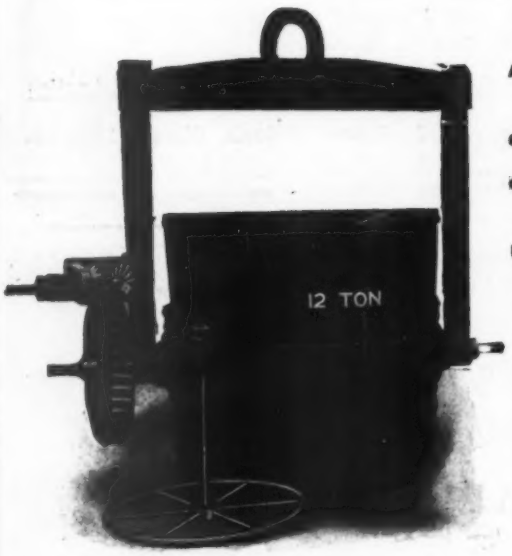
COAL DUST, CHARCOAL, PLUMBAGO and BLACK-LEAD, CORE GUMS and all Foundry Requisites, and have done so since 1831.

I. & I. WALKER, EFFINGHAM MILLS, ROTHERHAM.

Our Specialite is Studying Special Requirements.

KINDLY HAND US YOUR ENQUIRIES.

ALLDAYS FOUNDRY EQUIPMENT.



WE ARE MAKERS OF ALL KINDS OF FOUNDRY PLANT:— CLIMAX RAPID CUPOLAS, CLIMAX ROOTS BLOWERS, CORE OVENS, FANS, LADLES, MOULDERS TOOLS AND BELLOWS, BRASS FURNACES, (OIL AND COKE FIRED), BARROWS, OVER-HEAD CRANES, OVERHEAD TRACKWAYS, ETC., ETC.

WE ARE PREPARED TO QUOTE FOR ALL DESCRIPTIONS OF FOUNDRY EQUIPMENT.

ATTENTION IS DIRECTED TO ALLDAYS

NEW IMPROVED CLIMAX RAPID CUPOLAS.

PRICES ON APPLICATION.

THE CLIMAX RAPID CUPOLAS ARE MADE IN ALL SIZES FROM ½ TO 20 TONS PER HOUR MELTING CAPACITY, WITH OR WITHOUT RECEIVERS, SPARK ARRESTERS, CHARGING PLATFORMS, HAND HOISTS OR ELECTRICALLY DRIVEN HOISTS.

ALL KINDS OF CUPOLAS FOR ALL CLASSES OF WORK.

ALLDAYS & ONIONS PNEUMATIC ENGINEERING CO. LTD.,

DEPARTMENT "B."

Great Western Works, BIRMINGHAM,
And at 58, HOLBORN VIADUCT, LONDON, E.C.

Use More Steel or Wrot Scrap—Less Hematite.

Get out your charging sheet. Figure your saving by substituting 20 to 50 per cent. light wrot scrap for a corresponding amount of costly hematite or other high priced pig. This would be but one of the advantages of making McLain your foundry adviser and following

McLain's System.
Mixing Irons—Semi-Steel—Scientific Melting.

It is expert advice without the expert's price. It makes your foundry an A.1 shop and shows you how to keep it so. You begin to save on material, cut down losses and make better castings almost as soon as you start following the instructions and continue to do so as long as your foundry is in operation.

42,000 Pounds Tensile Strength Castings Direct from the Cupola

are possible making McLain's Semi-Steel.

Think of the added strength and wear this would give to many pieces you are now making in cast iron, some perhaps of which have been giving you trouble. Remember that the transverse is also proportionally increased.

Pieces you have never thought of making in cast iron because they would not stand up, you can safely make in Semi-Steel.

McLain's Semi-Steel is close grained, free from blow holes, hard spots, or segregation. Machines easily, takes a fine polish, tests higher, costs less but brings a higher price than good grey iron.

Absolutely Prevents Draws or Soft Spots at the Intersection of Light and Heavy Sections.

It Costs You Nothing to Find Out All About This — Send back coupon below.

McLAIN'S SYSTEM, 710, Goldsmith Building, Milwaukee, Wis., U.S.A.

Please send 32 page booklet "Semi-Steel" and full information free.

Name ..... Firm .....

Position ..... Address .....

1/14.

FERRO-VANADIUM. * * * **FERRO-TITANIUM.**
SILICO-MANGANESE {23/30 % Silicon, 65/70 % Manganese & 1 %, 2 %, 3 %, Carbon Maximum.
FERRO-SILICON Containing 25 %, 50 %, 75 % Silicon.
FERRO-CHROME 65/70 % Cr. & 1 % up to 8/10 % Carbon Maximum.
ALUMINIUM 98/99 % Purity. *In Notched Bars and Half Round Sticks and Granular.*
WE SUPPLY ALL CLASSES OF MINERALS, METALS AND METALLIC ALLOYS.
EVERITT & CO., 40, CHAPEL ST., LIVERPOOL.
Telegrams: "PERSISTENT." Telephone No. 1134 (3 lines).

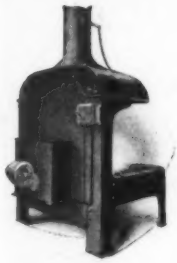
TN 918 HOP.

INDISPENSABLE IN FOUNDRIES AND ENGINEERING WORKS
THE NATIONAL PATENT CHECK ACTION TIME RECORDERS
The perfect machines for registering employees time and for job costing.
IMPORTANT.—The only card system Time Recorder which **will not register time for wrong days.**
MADE IN ENGLAND.
SIMPLE IN CONSTRUCTION.
RELIABLE IN ACTION.
INEXPENSIVE IN COST
Note the Name and be sure it is
THE NATIONAL TIME RECORDER COMPANY
Sole Manufacturers & Patentees,
5, Blackfriars Road, LONDON, S.E.

CUPOLA BRICKS
FOR LINING ORDINARY AND PATENT
CUPOLA FURNACES.
JOHN R. FYFE & Co.,
SHIPLEY, Yorks.

JOHN HALL & CO.
OF STOURBRIDGE, LIMITED,
STOURBRIDGE, ENGLAND.
Manufacturers of
FIRE BRICKS, BLAST FURNACE BRICKS AND CUPOLA BRICKS.

EFFICIENT AND ECONOMICAL HEATING OF FOUNDRY STOVES, . . . ANNEALING OVENS, FURNACES, &c. . . .
R. & G. HISLOP,
Gas Engineers, Underwood House, PAISLEY.



"KEITH-BLACKMAN"

Smithy Plants.

- K-B. Smith's Hearths with Blower combined.
- K-B. High Pressure Fans for blowing 1 to 100 Forge Fires.
- "Keith" Fans for Smoke Removal.

WRITE FOR CATALOGUE 156.

JAMES KEITH & BLACKMAN CO., LTD.

27, Farringdon Avenue, LONDON.

And at MANCHESTER, GLASGOW, EDINBURGH, NEWCASTLE, LEEDS, BIRMINGHAM, &c.

CORE OVENS & - - DRYING STOVES.

The latest and most satisfactory types on the market.

The door handles are on either end of the door and *never* get hot.

The door can be opened or closed with one hand. No hasps, catches, buttons or fasteners of any description.

No escape of heat when the door is opened.

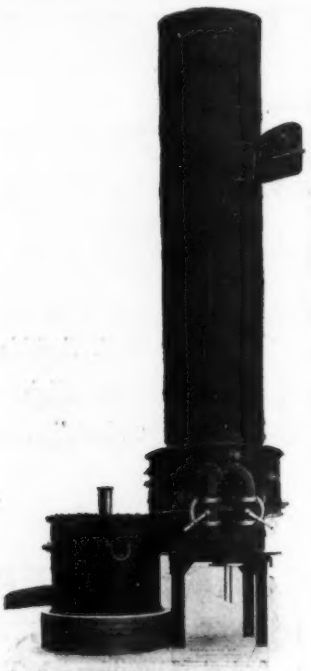
Made in all sizes with any number of shelves, at strictly competitive prices.

Please write for our Furnace List for the latest practice in melting plant and heating apparatus.

MURPHY, STEDMAN & CO., LTD.,

180, Gray's Inn Road, London, W.C.

FOUNDRY PLANT.



"Rapid" Cupolas

WITH OR WITHOUT RECEIVERS OR DROP BOTTOMS.

Roots' Blowers

FOR ENGINE, BELT, OR ELECTRIC DRIVING.

STEAM HAMMERS,
FORGE PLANT,
ROOTS' BLOWERS,
"RAPID" CUPOLAS,
FOUNDRY PLANT.
CENTRIFUGAL PUMPS,
AND FANS.
HIGH SPEED ENGINES
WITH
FORCED LUBRICATION
A SPECIALITY.
THE "BRADFORD" PATENT
BOILER FEED PUMP.
CATALOGUES ON APPLICATION.

THWAITES BROS., Ltd.,

BRADFORD.

LADLES, HOISTS,
PLATFORMS,
JIB CRANES, Etc.

London Office—

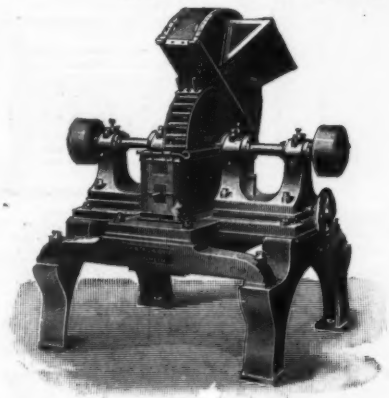
96 & 98, Leadenhall Street, E.C.

FOUNDRY PLANT.

SAND MIXERS. ROLL MILLS.
DISINTEGRATORS.

BRINCK & HÜBNER,
Mannheim, Germany.

Agents - SOHNAKENBECK & Co.,
40, Old Broad Street, LONDON, E.C.



METALLINE CEMENT COMPOUNDS

Are undoubtedly the most reliable of all Iron Cements procurable.

Applied as a putty; hardens quickly; when hard expands and contracts like iron.

Valuable to FOUNDERS, ENGINEERS and all IRONWORKERS for Stopping Up sand-holes, blow-holes, spongy pores, and other common defects in Castings.

Unequalled for repairing Engines, Boilers, Tanks, etc., etc., Perfectly resists steam, water, fire, gas or oil.

WRITE FOR FREE TRIAL SAMPLE AND INSTRUCTION BOOK.

MANUFACTURERS—

THE METALLINE CEMENT CO.,
112, Bath Street,
Glasgow.

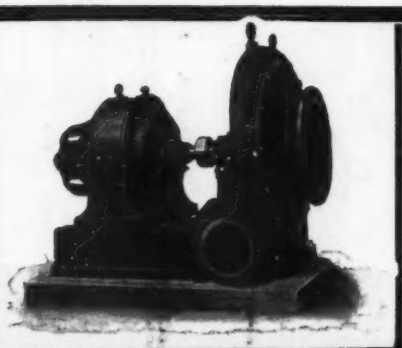
BLACKING
PLUMBAGO
COAL DUST
CHAPLETS
STRAW ROPES
CORE GUM &c.

FOUNDRY STORES.

Agents for "GLUTRIN."

Can ship cheaply to chief Ports on East, South and Welsh Coasts, also to Belfast.

THOMAS WILKINSON & Co., Ltd.,
MIDDLESBROUGH.



Aktiengesellschaft Kühnle, Kopp & Kausch Frankenthal-Pfalz.

TURBO BLOWERS, COMPRESSORS, VENTILATORS.

Represented by WITTING BROS., LTD., LONDON, E.C., 49, Cannon Street.

COMPLETE

Foundry Equipment.

Telegrams: "LADLES" MANCHESTER

Telephone: "No 2297 CENTRAL" MANCHESTER.

JAMES EVANS & Co. BRITANNIA WORKS, BLACKFRIARS, MANCHESTER.

145

PUBLIC LIBRARY
210192A
ASTOR, LENOX AND
TILDEN FOUNDATIONS

The Foundry Trade Journal
AND PATTERN-MAKER.

THE OFFICIAL ORGAN OF THE BRITISH FOUNDRYMEN'S ASSOCIATION.

Vol. 16. **JANUARY, 1914.** **No. 145.**

PUBLISHED THE FIRST WEEK IN EACH MONTH.

Subscription Terms: 7s. 6d. per annum, post free
To place the "JOURNAL" within the reach of Working Moulders and Pattern-makers the Proprietors will accept subscriptions, not less than three in number from one shop at the reduced rate of 5s. per annum, such order to be countersigned by the superintendent or foreman.
All communications to be addressed to the Editor, or to the Publisher, as the case may be, of
THE FOUNDRY TRADE JOURNAL,
165, Strand, London, W.C.

WE INVITE PRACTICAL ARTICLES ON THE TRADE IN ALL ITS BRANCHES, WHICH WILL BE PAID FOR. MSS. SHOULD BE WRITTEN ON ONE SIDE OF THE PAPER ONLY.

BRITISH FOUNDRYMEN'S ASSOCIATION.
LIST OF SECRETARIES—
General Secretary: E. A. Pilkington, Brook House, Sheepbridge, Chesterfield.
Manchester: A. Harrison, 705, Manchester Road, Castleton.
Birmingham: C. Grindlay, 39, Copeley Hill, Erdington, Birmingham.
Cardiff: H. Griffiths, Messrs. J. Williams & Sons, Ltd., Globe Foundry, Cardiff.
Sheffield and District: R. W. Kemlo, 6, Lees Hall Road, Meersbrook, Sheffield.
Scottish: J. Paterson, Royal Technical College, Glasgow
London: T. Murphy, 180, Gray's Inn Rd., London, W.C.
Halifax: J. G. Robinson, 17, Gibraltar Road, Halifax.
Newcastle-on-Tyne: H. A. J. Rang, Cleveland Road, North Shields.

Contents.

	PAGE
Notes and Comments	13
The Rennerfelt Electric Furnace	15
Covering a Pump Rod with Brass	18
Analyses of Cast Iron in Relation to Fracture and Grade Number	19
Pulverised Coal as a Fuel for Metallurgical Furnaces	22
Foundry Work from a Draughtsman's Point of View	23
Snap-Flask, Plate, and Machine Moulding	25
"F.T.J." Bookshelf	29
Foundry Sands and Their Treatment	30
Manganese Brass	32
Industrial Gas Furnaces	34
Plaster of Paris in Foundry Work	36
Cast Iron: Its Nature and Properties	43
British Foundrymen's Association	46
Openings for Foundry Progress	47
Correspondence	48
Queries	48
McLain's Semi-Steel	49
Oil-Fired Brass Melting Furnace	49
Inventions	50
Trade Talk	51
Deaths	52
Personal	52
New Companies	54
Prices of Metals	56
Legal	56

Forthcoming Events.

JANUARY 9.

British Foundrymen's Association (London Branch).—"Difficulties Overcome by Foundrymen," by T. Walker.

JANUARY 10.

British Foundrymen's Association (Lancashire Branch).—Annual dinner.

JANUARY 17

British Foundrymen's Association (Scottish Branch).—Open meeting for discussion on "Foundry Problems."

British Foundrymen's Association (Halifax Branch).—"Some Considerations on the Design and Working of a Cupola," by E. L. Rhead, F.I.C.; followed by annual dinner.

JANUARY 27.

British Foundrymen's Association (Sheffield Branch).—"Application of Town Gas to existing Core Ovens," by J. R. Hyde.

JANUARY 31.

British Foundrymen's Association (Newcastle Branch).—Annual dinner.

British Foundrymen's Association (Birmingham Branch).—"Loam Moulding," by S. G. Smith.

NOTES AND COMMENTS.

Foundry and Drawing Office.

Whenever it is desired to raise an earnest and forceful discussion among a gathering of foundrymen, it is only necessary to mention the subject of the drawing office and its attitude to the foundry. The discussion will then proceed merrily, particularly if one or two intrepid souls can be found to support the cause of the draughtsman and so add a little extra stimulus. We do not propose at the moment to labour this much-thrashed subject from the foundry standpoint; in fact, it would be fairer to take the opposite position for a while and so adjust the balance, for the stick is not always wielded fairly by a partisan, as the foundryman admittedly is. We propose rather to deal with a phase of the subject which is sometimes overlooked, and that is the value of drawings in the hands of the practical man. Taking foundrymen generally, only a small proportion can claim to be able to read with moderate understanding a correct drawing from the drawing office; and while it is admittedly not part of usual foundry instruction to study drawings and their meaning, it is also admittedly a great advantage to the foundryman to be able to understand if not to execute the draughtsman's work. Many are inclined to clamour for the latter to reduce his ideas into foundry language and present his designs so that the foundry can understand them. One suggestion has been that draughtsmen should give greater attention to perspective sketching in order that the pattern shop and foundry may be enabled to appreciate the meaning of the designs evolved. At first sight these suggestions seem very plausible, but it is equally if not more important that the foundryman should be able to study intelligently ordinary mechanical drawings. Perspective sketching may serve a very useful purpose, and the draughtsman who can apply that art is to be commended; but perspective drawing is not mechanical drawing in the strict sense of the term, and is not really necessary to the correct presentation of any design. In the first place, mechanical drawing is required to represent accurately the desired sizes and shapes, and is generally dimensioned to assist that end. Those same objects cannot be nearly so well attained with perspective drawing, which not only takes much greater time, but also is far more liable to inaccuracies, and does not serve the purposes of the mechanic nearly so well. A popular word picture may give an excellent general idea of the world's iron resources, but the economist in his computations requires to deal with the actual figures of tonnage. So it is with drawings; perspective sketches are the pictures and mechanical drawings the statements of plain fact. Nor are good mechanical drawings so difficult to read, once their principle is understood, that any one need fight shy of them. But here the drawing office may fairly come under criticism, for a very large number of drawings that are produced from important offices are not good—indeed, are distinctly bad, in that they are both inaccurate and hardly intelligible even to an experienced man. In some cases it would appear that if the draughtsman had visualised (as every good draughtsman must) the

mechanism in question, he had hopelessly failed to express his conception on paper—so much so as to render the drawing meaningless when drawing-office rules are applied. Even with quite simple designs the most misleading drawings are sometimes issued to the foundry. One recent example was a casting with a sunk boss required at one end only; the drawing showed plan, front elevation and an elevation of one end showing the boss, the natural presumption being that the view represented either end since the other was not indicated. When, however, the castings were so made they were returned as being wrong and useless. Here much expense and trouble were incurred owing to the absence of half a dozen necessary lines on the drawing.

Another common fault is the tendency to economise paper and time by cramming into one view a mass of detail, often by the use of broken sections and dotted lines representing parts "somewhere behind." To one familiar with the apparatus they may be intelligible, but to another person they convey no idea at all. Then again, in many complicated drawings centre lines and dotted lines indicative of hidden construction are stupidly confused, until it is impossible to tell what half of them mean. Section-lining or "hatching," also, is frequently not uniform in its significance, even on the same drawing, with the result that it conveys either a wrong impression as to the materials or no impression at all.

Certainly let foundrymen, from the core boy up to the foreman, understand and be able to read mechanical drawings; but also let the drawing-office turn out systematically work which is intelligible and correct—at least intelligible to men who can read drawings, and correct enough to avoid errors if the drawings are followed. There appears to be far too much liberty allowed to the ingenuity of the juniors in some offices, with the result that a desire for variety of style of expression produces quite weird results. There is one other point which often leads to confusion, and that is the position in relation to the plan or elevation on which the other views are projected. A common practice in this country is to follow "odd-side" projection (*i.e.*, project a left-hand end view on the right-hand side of the drawing), while in America it is usual to project on that side from which the object is viewed. The latter appears to be the more rational method, but the "odd-side" practice is now commonly taught. It does not matter which rule is followed so long as an indication is given; though it most frequently is not given, and endless confusion arises. Without question there is much room for improvement in the drawing-office, and until something nearer system and standard practice is adopted we may look in vain for a general knowledge of drawing work amongst foundrymen.

A Question of Names.

Once again there crops up the vexed question of a name for a device which has lately come into greater prominence under the title of "chill," though quite distinct from both the effect known as "chill" and the means of producing that effect. Before a recent meeting of Birmingham foundrymen, Mr. R. Buchanan remarked that the "chill" mentioned by the lecturer as being used on a test bar was the body used to densify the metal and not the chilled bar. Some term was badly needed to define the thing that caused the chill—to differentiate cause and effect. The body which was used to cause the chill was termed a "chill." He submitted that a term which might be used for the exterior chill, when used to give a denser metal without actually producing a chilled or white iron, was "densifier." On this subject we may refer to a similar suggestion put forward in these columns just twelve months ago. We then remarked, in connection with the use of the term chill, "it is highly desirable to adopt a less misleading name for the device employed to assist rapid cooling and the production of a dense structure. . . . In view of the function of producing a dense, close structure, we think it will be difficult to find a more suitable term than 'densener,' and we submit that this should be used in place of the terms 'chill' or 'chiller.'" It is not surprising that the suggestion has not yet been adopted in many quarters, but we think it would be well were the council of the British Foundrymen's Association to give official countenance to some such suitable term. We prefer the term "densener" to "densifier" as being more euphonious; but it is of little consequence which is adopted so long as it is distinctive and not ambiguous. At the same time it would be well to establish the differentiation mentioned by Mr. Buchanan regarding the term chill when correctly applied. The effect produced by rapid cooling (*i.e.*, a white, hard structure) has alone the right to the term chill. It is somewhat unusual to take lessons in the English language from America, but in this matter the latter country is certainly ahead of us; there the effect is known as a chill and the cause as a chiller. This is strictly correct, and we cannot do better than adopt the same denomination.

A Glance Backwards.

The foundry trade, while it is in some respects distinct from the general iron and steel trade of the country, is nevertheless in close sympathy with it and is affected by the general rise and fall of that trade, in conjunction with engineering and shipbuilding. It may be interesting to recall, then, the general tendencies of the iron and steel trade of the past twelve months. The year 1913, although it has witnessed the end of a boom, and the beginning of a period of comparatively dull trade, has been a prosperous year in the iron and steel industries. But there has at the same time been a steady decline in the volume of new business. It became increasingly evident as the months went on that the phenomenal demand which marked the preceding two years had spent its force, and that enterprise and development were being curtailed. The second Balkan was and the general uneasiness which it occasioned throughout Europe brought on a period of financial stringency, and a consequent disinclination on the part of consumers of iron and steel to consider other than immediate requirements. Yet the volume of trade as a whole has been very substantial, and will be found to be well up to the average of the past ten years.

In regard to the future, a quiet business at lower levels may be fairly expected in the ensuing year. The shipbuilding position is a factor favourable to the continuance of activity, but this, too, requires some little qualification owing to the peculiar conditions obtaining in the shipyards. The shipbuilding history has, it is true, enjoyed a year of great prosperity; but the output would undoubtedly have been greater had it not been for the lack of skilled labour and the loss of time on the part of workmen delaying the completion of contracts. This has had, indirectly, an unfavourable influence upon business in the trades which depend largely upon the shipyards. The shipyards have still contracts running at high prices, and in this and other respects the present year starts fairly well. However definite the slackening in business may be, there is at present no real justification for adopting a pessimistic attitude as regards the future of the foundry trade this year.

The Rennerfelt Electric Furnace.

By Axel Sahlin.

In the year 1912 Mr. Ivar Rennerfelt, a Swedish engineer, constructed at Hallstahammer, Sweden, an electric furnace on a principle differing from all types previously in actual operation. The trial was so successful that, within a year, a steel foundry containing four Rennerfelt furnaces was constructed at Hallstahammer. During the period from April to November, 1913, seven furnaces have been put in operation, a number have been ordered from Sweden, Norway and Russia, and repeat orders are being received. The furnace covers a field which has not yet been fully covered by any previous type, viz., an economical small furnace for crucible works, steel foundries, copper smelting, glass melting, also for melting ferro-manganese, ferro-silicon and pig-iron alloys, and for chemical processes. The principle is applicable to small units of 2 cwts., as well as larger sizes, and the 30- to 50-ton electric refining furnace for steel and iron is in sight. The furnace is owned by a Swedish Company, the Aktiebolaget Elektriska Ugnar-System Rennerfelt. This Company has its offices at No. 2, Fredsgatan, Stockholm. The general agency for Great Britain, Belgium, Germany, Austria and Hungary is in the hands of International Engineering Company, successors to Julian Kennedy, Sahlin & Company, Limited, 52 Rue du Congrès, Brussels, and Prudential Buildings, Sheffield.

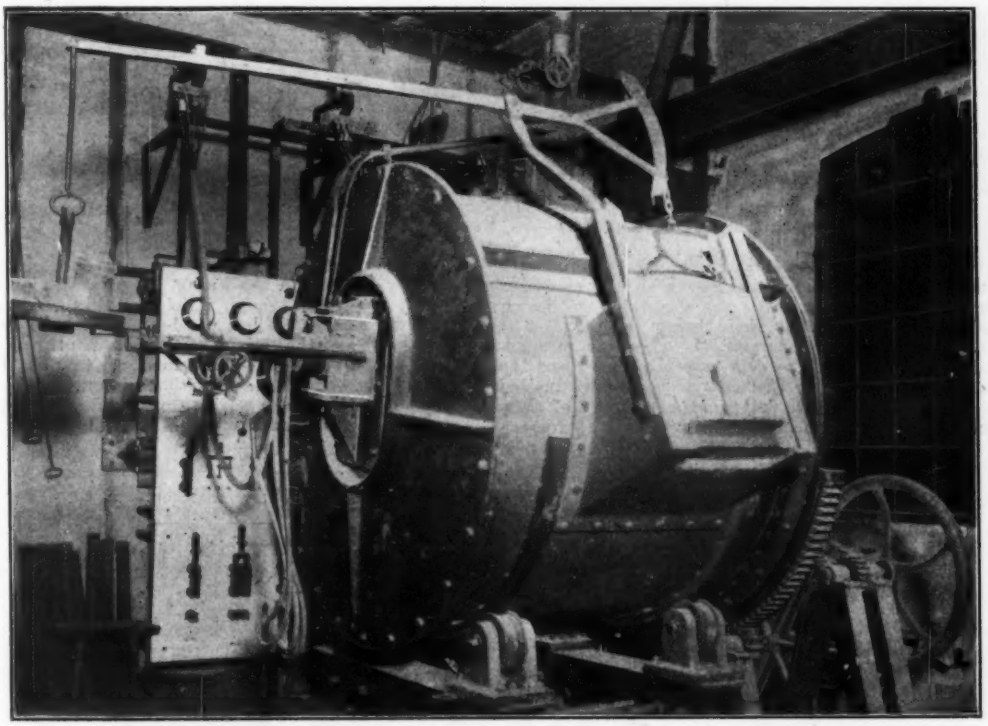


FIG. 1.—25-CWT. RENNERFELT ELECTRIC FURNACE, AT HALLSTAHAMMER, SWEDEN.

Description.—The Rennerfelt furnace is preferably built with a horizontal cylindrical steel shell, rolling in cradles or tilted by revolving on a horizontal axle. It is lined with silica, carbon or magnesite brick, according to the work for which it is intended. A closely-fitting charging and casting door is placed in one side or in each end of the furnace. The current is circulated by three electrodes, one central electrode descending vertically through the crown of the roof, flanked on either side by one horizontal, entering through the ends or sides of the furnace. These latter are adjustable longitudinally and also vertically. In ordinary practice the electrodes do not come in contact with the slag or bath. The arcs are free burning.

Three-phase current is passed into a transformer for Scott's method of phase transformation, changing the entering energy into balanced two-phase current, and delivering one-phase current to each of the horizontal electrodes. A return cable connects the common point of the two phases with the central electrode. The currents entering through the horizontal electrodes neutralise one another, but the action of the returning current into the central electrode generates a field of force which deflects the arcs downwards towards the bath, thus forming the arcs into an inverted arrow head or a "Fleur de Lys." This form of arc has hitherto been unknown in electric furnaces, and is one of the principal reasons for the success of the Rennerfelt furnace. The heat generated in the arcs is, to an exceptional

extent, concentrated down upon the bath though the electrodes do not come into contact with either metal or slag. The height of the arcs from the points of the electrodes to the surface of the bath can be adjusted, but is usually kept at about 6 in. to 12 in. Smaller sizes of furnaces are tilted and discharged by hand-lever and ratchet movement, larger furnaces by electric or hydraulic mechanism.

Operation.—The Rennerfelt furnace is a large crucible, and can be charged with cold or liquid metal. If cold, the metal is charged by hand into the pre-heated furnace, together with the necessary fluxes. During the charging the electrodes are drawn back, so as to prevent their being injured. The furnace having been charged, the electrodes are adjusted correctly, and the door carefully closed and the current turned on. The charge is rapidly melted and covered by a thin but unbroken sheet of slag. There is just enough activity in the bath to form a neutral or reducing atmosphere in the furnace. No air is admitted, the door remaining closed until the charge is almost completed. Samples are then taken, recarburisers and alloys are added as may be required, and the furnace is emptied, the steel being poured into the waiting ladle at a temperature much higher than that obtained in the open-hearth furnace. The bottom and slag line are fettled, if required, with ground dolomite or ganister, and a new charge is made. One steel-melter and two labourers, or boys, per shift can manage a furnace melting from three tons to six tons of steel or more per day of 24 hours.

Lining.—In the riveted steel shell is placed an insulating lining of half-inch asbestos board. Silica or first-quality firebricks in rings are built up against the asbestos board, and form the bedding for the actual inner lining. This is made of silica, carbon or magnesite brick, set in rings of different diameters so as to form an egg-shaped interior melting chamber. The bull's-eye around the charging door is carefully fitted into the lining. Special bricks form circular openings through which the electrodes enter into the furnace. It has not been possible to determine the life of the linings in the few months during which the furnaces have been in operation, but basic linings have run 110 heats without requiring repairs, and acid linings are in working order after more than 174 heats. The temperature is much higher in the basic furnaces. The circular form of the furnace is one of its greatest advantages. The radiating heat from the free-burning arcs is reflected on to the bath from the entire mirror-like incandescent inner surface of the vault. Yet the arcs are at such distance from this roof that the danger of melting the same is minimised. The shadow of the vertical electrode has a marked protecting influence on the vulnerable portion of the vault, the area around the entrance opening for the said electrode. There is no break

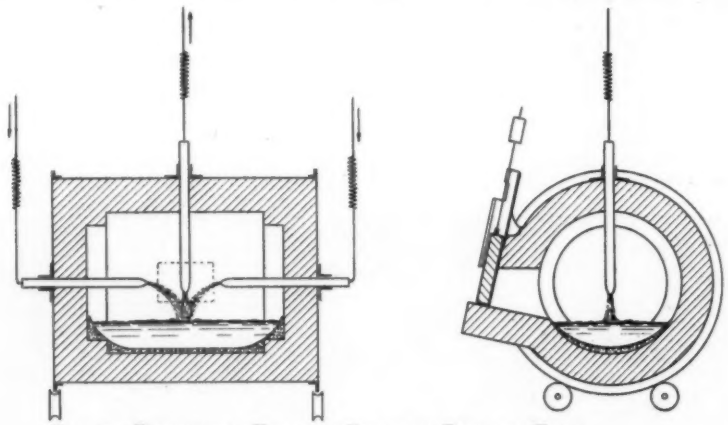


FIG. 2.—RENNERFELT ELECTRIC FURNACE; ROLLING TYPE.

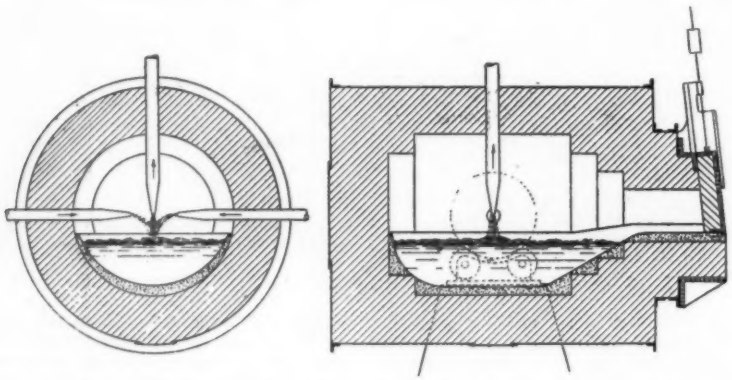


FIG. 3.—RENNERFELT ELECTRIC FURNACE; TILTING TYPE.

between the roof, side walls and bottom, all being built together in one continuous curve. Owing to the comparatively small radius of the roof the arch is exceptionally strong, and the disadvantage of expansion and contraction of the lining is reduced. As the furnace is not only durable, but also small in comparison to its capacity, the cost of renewals of lining is low. To facilitate re-lining, the cylindrical shell is divided into an upper and a lower half, the two being bolted together when lined.

Electrodes.—The electrodes are held with a loose fit in water-cooled, insulated phosphor-bronze boxes or holders, those for the horizontal electrodes being adjustable also in the vertical plane. The power cables are attached to the holders, the current being transmitted through brushes consisting of powdered graphite held in place by copper-wire netting. The electrodes, which for a 12-cwt. furnace measure 2 in. in diameter, and for a 2-ton furnace 3 in and 4 in., are of the make known as the Acheson graphite electrodes. They are turned to diameter specified, and made continuous by threaded sockets and dowels, the new section of electrode being screwed on to the section at work as this is being consumed. For smaller furnaces the electrodes, which can be touched without shock, are fed by hand. For larger furnaces a hand-operated feeding mechanism has been added. For very large furnaces automatic feeding will be employed.

If we assume the strength of the ingoing current at each side electrode to be a amperes, then the magnitude of the current passing the central electrode equals $a\sqrt{2}$ amperes, provided that the power on the two side electrodes is perfectly balanced. The electrodes, which fit very snugly in the holders, are turned down to small diameters ranging from 1½ in. for a 500-lb. furnace, capacity 3,000 lbs. per day, to 4 in. for a 5,000-lbs. furnace, capacity 30,000 lbs. per day. The 1½ in. Acheson electrode, the smallest employed, will carry without damage 450 amperes per sq. in. section. Larger electrodes, 4 in. diameter, ought not to carry more than 200 to 250 amperes per sq. in. The tension of current in the electrodes should vary from 60 volts to 125 volts, according to size of furnace. During the period of melting a cold charge the resistance between the points of the electrodes changes continually and rapidly, but as soon as a bath has been formed the resistance, and consequently the current, becomes steady. It is then easy to adjust the side electrodes so as to evenly balance the current between both sides. The regulation is effected by gradually advancing or withdrawing the horizontal electrodes. The vertical electrode need but seldom be touched. Once the arcs are adjusted, it suffices to advance the side electrodes by about 1 in. every hour. The consumption of Acheson electrodes per ton of steel is less than 6½ lbs.

Reactions and Results.—These depend upon the purpose for which the furnace is used:—

(a) One Swedish firm employs an acid 12-cwt. Rennerfelt furnace for making the highest grade of electric crucible steel employed for cutlery, sawblades and tool steel. This furnace is lined with silica brick, and gives the same reaction as the crucible. The quality of the steel depends in this case largely on the material charged. The furnace requires 800 to 1,000 kw.-hours per ton of steel made. The current supplied is 100 kw. The stock, carefully selected, is charged cold. The bath is soon covered by a thin layer of slag, along the surface of which are seen red flames radiating from the inverted arc towards the walls of the furnace. There is no boiling, only a slow circulation of the metal, permitting any small globules of slag which form to rise to the surface. The atmosphere in the melting room is slightly basic, and the formation of gas is just sufficient to prevent the oxidising air from entering the furnace, which thus acts as a large crucible. As compared with the crucibles, the economy is marked.

(b) A basic furnace of 12 cwts.' capacity, with magnesite lining, is operating in a Swedish steel foundry producing special steel castings. The charge is made up of cast-iron and steel scrap, ore and lime. There are only 90 to 100 kw. of current available, and the melting down requires about 1½ hours. The duration of the heat is about 3¾ to 4 hours. Owing to the high temperature maintained—some 2,400 deg. to 2,500 deg. C.—sulphur and phosphorus are largely eliminated, as well as silicon, carbon and manganese. The refining can be carried to any point desired by pouring off and renewing the slag. Owing to the great fluidity of the steel at the high temperature, very thin and difficult castings can be successfully made. After operating this furnace for six months, the owner constructed a larger power plant, and placed an order for a second Rennerfelt furnace for 3-ton charges. With a working staff of four men per shift, the two furnaces will give an output of about 18 to 20 tons of steel per 24 hours.

(c) *Neutral Lining.*—Experiments are under way to ascertain the actual economy arrived at by the employment of carbon brick instead of magnesite.

Power.—In small furnaces about 8 tons of steel will be produced per 1 kw.-year of power. It is therefore evident that, though low cost of power is desirable, a higher price per kw.-year will not be prohibitive.

Larger Units.—Though it is not yet a year since the first small Rennerfelt furnace was started, larger furnaces of up to three tons' capacity are running and being constructed. There is, however, no objection to extending the cylindrical furnace and fitting it with additional sets of electrodes spaced about 4 ft. apart. Using four sets of electrodes, a cylindrical furnace with a bath 20-ft. long exposed to equally-distributed electric heat would be formed. Such a furnace would hold a charge of 25 to 30 tons. It should be placed on a tilting cradle operated by hydraulic or electric power. There should be one charging and tapping door at each end of the furnace, through which also repairs of the interior could be effected. This size, however, is not a limit, as it would be quite practicable to build a furnace of the same diameter, 30 ft. long, to take a charge of 45 tons. These larger furnaces will be especially economical as adjuncts to a Bessemer or open-hearth plant for the further refinement of metal. Judging from the smaller furnaces, the refinement of such metal will not require more than one hour's time. Such a refining plant would not only be compact and economical wherever cheap electric power is available, but would also be cheap in first cost and would ensure a superior product.

Employment —The Rennerfelt is specially a *large crucible*, but is also well adapted for steel foundries, for refining cast-iron, for melting ferro-manganese, ferro-silicon and special steels. As the electrodes never touch the slag or bath, it should be particularly suited for melting copper, bronze or other alloys, and also for various chemical melting processes.

Claims.—The furnace claims the following advantages:—

(a). Any direct or alternating electric current may be used, independent of frequency.

(b). The construction of the furnace and its lining minimises radiation of heat.

(c). Openings for the electrodes are small, and therefore do not essentially weaken the roof. Only one or two doors are needed to make accessible the entire interior of the furnace.

(d). No fuel is required in the melting chamber to sinter the fettling or warm the furnace.

(e). The position of the arcs high above the surface of the charge causes the heat to spread uniformly over the surface of the bath, reflects the heat downward from the roof, and engenders chemical activity between steel and slag.

(f). The elevated position of the electrodes protects them from the oxidising influence of the slag. It permits the charging of the furnace cold without injuring the electrodes, and makes it permissible to tilt or even empty the furnace without cutting off the current. Boiling in the bath when decarburising pig-iron with ore does not affect the power supply. The electrodes are entirely consumed. They are spliced as consumed by screwing new sections on to those at work, without cutting off the current, and the consumption of electrodes is small.

(g) The doors being closed, the generation of gas in the furnace is sufficient to prevent ingress of air.

(h). The regulation of the power is simple. Only the side electrodes need periodical attention. The distance of the electrodes from the charge (and from each other) may be altered without any change in the amount of heat generated by the arcs, and without turning off the current.

(i). The phase displacement is small; a value of Cos ϕ = 0.97 corresponding to an angle of displacement of 14 deg. at 50 periods has been obtained, showing that the furnace load is practically non-inductive.

(j). The space occupied is small. Neither compressed air, steam nor hydraulic power is required.

(k). The cost of labour is very small compared with that required for crucible melting or the small open-hearth furnace.

(l). It is possible to stop the furnaces during shop hours or during hours of peak loads. The power required for keeping the furnace hot is only about 15 per cent. of the full charge for the larger furnaces, or at the highest 30 per cent. for very small units.

(m). The first cost of plant is low.

(n). The cost of production is low compared with all other methods for producing high-grade steel in small or moderate quantities.

Cost of Manufacture.—This, of course, depends wholly on local conditions. The principal and most variable factor is the cost of current. According to experience in Sweden, one kw.-year will produce:—

	Tons.
In a small furnace—tool steel	8
In a small furnace—soft steel for castings	9
In a large furnace (estimated), refined liquid steel from Bessemer or open-hearth	40
In a small furnace, cast iron melted and refined	22

A basic Rennerfelt furnace of 12 cwts.' capacity, producing 3 tons of soft steel per day, is producing liquid metal in the ladle at the following cost:—

	Shillings per ton.
1,025 kgs. scrap at 66s. per met. ton	67.65
Recarburiser and additions	3.10
Electrodes, 3 kg. (6.6 lbs.), at 1s 3d per kg.	3.75
Labour	10.00
Repairs and renewals	5.00
Depreciation, 10%	2.50
Royalty	4.00
Sundries	2.00
Total	98.00
One-ninth of a kw.-year at 36s.	4.00
Total cost of metal	102 00
If kw.-year cost had been 72s., cost would have been	106.00
" " " " " 144s., " " " "	114.00
" " " " " 288s., " " " "	130.00

Cost of Installation.—Inasmuch as a small furnace can be placed in almost any shed in which a 2-ton crane may be installed, and as electric current can, in most cases, be drawn from an existing central power station, it is claimed that the cost of the actual plant will be so low that its installation would be justified in almost every steel plant and foundry.

Covering a Pump Rod with Brass.

By John H. Lumsden.

In the work of covering a pump rod with brass there are numerous little but important points that seem to have been overlooked by many who have discussed this work. The following is a description of the way in which one of these rods was recently covered by the writer.

The rod was 7 ft. 3 in. long, and the part covered, from A to B in Fig. 1, was 3 ft. The box used for moulding it in was 4 ft. long, with holes

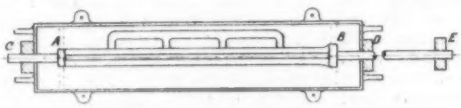


Fig. 1.—Bottom Box.

at each end, leaving 2 ft. 9 in. of the rod at the one end and 6 in. at the other, outside the actual box. A pattern was used for ramming-up purposes and a binder fastened across the box at A and B both in the bottom half for supporting the rod and on the top half to keep the rod from yielding in any way when placed in the mould ready for casting.

As the rod has to be heated before pouring the metal, the gas which accumulates must find a quick

Fig. 2.—Top Box.

egress, so if the runners are cut on the bottom half only to allow the metal to flow in evenly and five open risers made as shown in the sketch, this difficulty is surmounted.

The rod should be heated till it is a dull red, and during the heating must be kept turning in the fire. If it is allowed to remain in one position for any

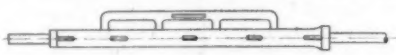


Fig. 3.—Plan of Casting.

length of time when heated, there is always a danger of it twisting. When the mould is ready for casting, binders should be used top and bottom at C, D and E, so that it will be firmly kept in position; and as there are handles on the box at C and D it is easily wedged by jamming in pieces of iron between the handles and the rod and at E by two

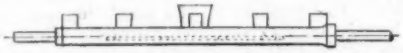


Fig. 4.—Elevation of Casting.

weights. This job is always better made in dry sand. In green sand an unnecessary amount of steam is created. Everything should be fitted on before treating the rod so that no time is lost in getting it ready for casting. The casting should be left till cold before lifting.

Analyses of Cast Iron in Relation to Fracture and Grade Number.

By Sidney G. Smith.

(*All Rights Reserved.*)

Judging by fracture the quality and suitability of iron for any particular work is regarded as "rough and ready," but a very uncertain method; it is considered more scientific to mix iron by analysis and rely upon its results. The writer submits to those who have had a wide and varied experience in different brands of iron, that to rely absolutely upon either method alone and under all circumstances is to court disappointment. The man of experience in his judgment by fracture may attain approximately what is required for many kinds of castings, just as well as the chemist will by analyses—that is within certain limits, beyond which the experienced chemist will have the advantage. But the man who is gifted with judgment in fracture, in addition to knowledge of analyses, is certainly in the best position.

We may first examine the methods and the bases upon which these two work—the man who judges by fracture and the chemist who partly relies upon analysis. (It is here taken as understood that both are experienced and practical men in foundry work.) It has been asserted, and it is freely admitted that cast iron is not now so easily judged by fracture as was formerly the case. But still, apart from pig-chill casting, there are certain characteristics remaining.

We will assume that the foundryman who judges by fracture is quite ignorant regarding the percentages of graphite and combined carbon, silicon, phosphorus, manganese, sulphur, etc., or their influence upon iron. When castings are required which he thinks demands a certain quality of iron, or perhaps the quality of iron is specified, if a stock of pigs of different brands and grades are available (but alas this is too often not the case), he inspects what there is in stock and selects that which he thinks will meet the requirements. He is acquainted with several brands of iron. If he is in doubt (which he often is) he will break with a hammer the doubtful pigs, taking note of the blows and their sound or ring. If the work required is very important, he will probably put a charge in the cupola at the end of the day, and cast both tensile and transverse bars from it. These will be broken the following day, and the results known; the fracture of the bars can be examined, and if necessary their machining qualities tried. If he is still not satisfied, further trials are made on similar lines, probably with a mixture of grades, brands and scrap.

What, now, are the factors, or characteristics, that decide the selection of iron? The foundryman knows that with every brand of iron there are grades, or numbers, generally No. 1 to No. 5 inclusive, mottled and white; that a No. 1 has a very open fracture and is dead soft iron; and that as the numbers rise so does the fracture become closer, lighter in colour and the iron more dense. There are certain other indications in pig fracture, to which reference may be made later, which do not come within the scope of knowledge of those who judge by fracture appearance only. If, then, the casting required as a steam, hydraulic or air cylinder, where resistance to pressure and shock and machining qualities must be combined, a No. 3 or 4 grade is selected, this being known to melt clean and dense, and to have more or less the qualities just named. The foundryman will reason that the No. 3 will carry a fair amount of close scrap, or the No. 4 will carry some heavy scrap or will even do without any scrap at all. If his employers buy iron in the open market there are often certain brands which have a reputation with which he is acquainted, and such are always given preference. He reasons similarly if he deems the work in hand to require a softer or a harder iron; if the former, a No. 2 grade with certain scrap is selected; if the latter a No. 4 grade with small scrap is mixed, and so on. He has also gained knowledge by experience in mixing widely different grades and brands of iron and scrap suitable for many kinds of castings by remelting. The result in each of these cases may, or may not, be satisfactory. The writer is aware that the wisdom of this is very often questioned, the contention being that irons of a widely different composition will not mix, but practice and its results have at any rate in numerous cases proved otherwise, as the writer can testify, though admitting that manipulation in mixing is important in securing success. If the foundryman is asked the composition and percentages of the metalloids in these mixtures, he replies that does not trouble him so long as a satisfactory casting can be produced.

In the case of the practical man who has some definite knowledge of the composition of iron and the influence of varying percentages of the metalloids as shown by analysis, he certainly ought to hold an advantage since he should possess knowledge of fracture in addition to metallurgical knowledge. The metallurgist of experience can approximately forecast under normal cooling what kind of fracture some analyses will or ought to give, but even the metallurgist, like the man who judges by fracture, has his limitation in this respect. Regardless of his reliance upon analyses, the chemist will always look at the fracture, owing to occurrences in cast iron being so uncertain.

The metallurgist has the advantage of knowing that the influence of carbon is to harden iron under certain circumstances, and soften under others; also that manganese and silicon are capable of the same influence; that the chief virtue of phosphorus is to give fluidity; while sulphur imparts hardness.

The relation between analysis and fracture under normal conditions in ordnary cast iron should be that high carbon and silicon, say 4 per cent. and 3.5 per cent. respectively, will show in the pig a large open graphite fracture; the iron will not be above 1 per cent. in manganese and very low, probably 0.02 per cent. in sulphur. Phosphorus, whatever its content in a brand, will almost remain constant, regardless of brand numbers. A high carbon accompanied by a high silicon, say 3 to 3½ per cent., tends, apparently, to soften, not from any softening virtue in either carbon or silicon alone, but through the influence of a high silicon upon the carbon causing the

formation of graphite, the large facets of which break the continuity of the matrix and impart a softness which is attributable to a high percentage of graphite carbon, consequently a low specific gravity, and corresponding to a No. 1 iron of any foundry brand. Even if the silicon is not very high, a high-carbon iron will often exhibit the same characteristic.

When the silicon exceeds 3½ or 4 per cent., as it sometimes does, its influence is, irrespective of the carbon content, to produce a closer and finer fracture, and to slightly harden the iron, which in this condition is termed silvery or glazed and often a burnt iron. Properly, it should be called a siliceous iron. It is with such iron that discernment in fracture is uncertain, but when closely examined the fracture will be smooth, glazed or glassy, and devoid of tenacity. This iron has a cold-short break, and is sometimes termed "potty," which implies that it breaks like crockery-ware. There is often a demand for such iron in the foundry, where it is used as a softener.

As regards No. 2 iron, the fracture is less open than a No. 1, *i.e.*, the graphite facets are not so large, consequently the matrix is a little less broken. It is generally not so high in either carbon or silicon. Combined carbon will be present to a small extent, and hence this number will not be quite as soft as No. 1, but a little more tenacious. The sulphur content may be a little higher, and the specific gravity is higher.

A No. 3 iron shows smaller graphite facets than No. 2, not because it contains less total carbon, but because the carbon becomes divided as the numbers rise, *i.e.*, part of the carbon combines with the iron, leaving less to assume the graphitic form. Less silicon and slightly more sulphur will be found in No. 3. (which partly accounts for the reduction in graphite) and the combined carbon is higher. The fracture is finer and closer in texture, and the iron still more tenacious and harder.

In a No: 4 iron there is an entire absence of large, free graphite facets, or patches, the fracture being usually quite uniform and regular. The total carbon may be the same as in No. 3, but the free graphite is lower, and the combined carbon higher. The metalloids and iron are more uniformly combined or mixed, chemically or mechanically, hence the fracture shows an iron of strong tenacious cleavage of fairly high density and hardness. The sulphur content may reach 0.05 to 0.06 or even higher, while the silicon is less than in the other numbers.

No. 5 iron shows a closely-knit fine granular fracture, and upon close observation often discloses, even to the naked eye, fine net-like intersecants of a lighter colour than the mass intertwined throughout. This may be due to the formation of pearlite and cementite, as the total carbon in this iron is approximately divided equally between graphite and combined carbon. The silicon content is lower than in the preceding number, and the sulphur higher. No. 5 is fairly low in total carbon, say 3 per cent., with manganese, silicon, and phosphorus not above 1 per cent. each. It gives good physical tests with standard test bars, in either transverse, tensile or crushing tests. The tenacity of the fracture is greater than that of No. 4, and the fracture-surface appearance is rough and irregular, which is often a good indication of a strong cast iron. It is dense, but will not be excessively hard, except in very thin castings, and is easily machineable. When charging such iron in the cupola, scrap, unless of a very open nature, should be avoided.

The fracture of mottled iron cannot be misunderstood; patches, streaks and spots of white iron are plainly visible embedded in the mass of more or less light-coloured hard grey iron, the surface of the fracture is smooth, although a little irregular, denoting a lack of cohesion or tenacity. The silicon content is low, and the sulphur higher than in preceding numbers. Less than half the total carbon is in the graphite form, and possibly the remaining carbide assumes to a large extent the cementite state.

White iron has a fracture which is fine-grained, smooth, uniform and regular, and white. It is extremely hard and brittle, unmachineable, and lacks tenacity, breaking into pieces with slight blows. The silicon content is at its lowest and the sulphur at its highest, while practically the whole of the carbon is in combination with the iron.

The foregoing changes in composition, fracture and appearance of grade numbers apply correspondingly to all brands of pig-iron, and are produced by thermal changes, which depend upon the burden, blast, fuel, flux and general working of the furnace.

To judge with certainty from the appearance of iron in the liquid state regarding its grade number, requires experience and long association with furnace plants in different districts. There are characteristics in the flow, surface break, temperature, etc., when understood, which give some indication of the nature of the iron, but such indications are not infallible. It should also be borne in mind that, even with furnaces working on a regular burden and under apparently normal conditions, it sometimes happens that the fracture grade does not agree with the analysis, or that the analysis does not agree with the fracture, *i.e.*, any particular grade of iron may contain an abnormal amount of one or more of its elements—for example a No. 2 grade may contain high sulphur, or a No. 4 or 5 grade very high silicon, and *vice versa*. These may be called freak occurrences, but they exist, and it is with such occurrences that analysis becomes the detective. This indicates the necessity for occasional analysis of all brands and grades of pig, because with an important casting demanding certain qualities, or a large number of small ones, the effects of an unknown quantity may be disastrous for the founder, although the fracture and grade appearance may be quite in order.

Silicon Control.

The basis upon which foundry chemists chiefly work (rightly or wrongly) is silicon content in relation to thickness; but there are many castings that require an iron in which the other elements are controlled, silicon being of little importance except that it must be low, or almost absent. Reference to this will be made later.

Special Brands.

The strongest cast iron is that which contains the least amount of metalloids. Some brands of cast iron contain 96 per cent. of iron, while the majority of brands contain 92 per cent. Certain brands are noted for low carbon, silicon and phosphorus. Others are noted for being high in these elements. Again, other brands are rich in manganese and low in sulphur, while others are the reverse. An admixture of brands and numbers made with a view to keeping the total impurities down undoubtedly gives a strong iron. The initial temperature must necessarily be high, and the range of fluidity is narrow in comparison with an iron of medium phosphorus or silicon. If, as before stated, the carbon can be kept below 3 per cent., silicon and phosphorus below 1 per cent., and manganese about 1 per cent., a strong and enduring iron should result, which would give satisfactory high physical tests and be dense; the specific gravity, of course, would be fairly high.

Whilst it is true that irons of the same composition which are high in metalloids will give widely different results in physical tests, under altered conditions, such as rapid cooling by means of chills, it is also true that an iron which is low in metalloids will give correspondingly better results under the same conditions.

The fracture appearances of various grades and numbers, and their relation to analysis, although inevitably associated with uncertainties regarding composition and ultimate physical results, are yet useful in checking many irregularities in normally cooled irons, whether in the pig form or otherwise.

Microscopic Examination.

Reference may now be made to the comparatively recent science of micrography. The revelations which are possible to the microscopic expert are interesting and fascinating to the foundry student. The writer at one time held the opinion that micrography was simply a more advanced method of examination of fracture, but upon further study regarded the method in a broader light. Not only can the constituents be identified, but also their relative state or condition, as carbides, eutectics, ferrite, graphite, pearlite, cementite, etc. Also the general structure of the matrix or mass can be disclosed. Analysis of cast iron only recognises two forms or modes of carbon, viz., graphite and combined carbon, and determines the content of each of these forms, in addition to the amount of silicon, phosphorus, manganese, sulphur, or other constituents. Micrography takes up the thread of determinations where analysis leaves off, and reveals the structure, which varies in many ways with metal which is the same in composition so far as analysis is concerned, these variations being affected by the cooling of the iron.

Rapid cooling of ordinary foundry iron will always increase the combined carbon, though, of course, such increase will, to some extent, depend upon the analysis, or grade, and brand of iron used. For example, a No. 1 grade of iron which is high in silicon and low in sulphur, will not chill so definitely as a No. 4 or 5 of the same brand, leaving out of consideration the thickness of the piece chilled. The combined carbon (carbide) which is thus increased may exist in two forms, both of which come under the same formula Fe_3C, viz., pearlite and cementite, and in which form it exists can only be ascertained accurately by the microscope. Although it is considered that in a cast iron containing a certain amount, say, 0.57 per cent., of combined carbon, it will exist chiefly as pearlite, above that amount to, say, 0.9 per cent. it may exist as both pearlite and cementite; above, say, 2.5 per cent., as in white iron it will exist as cementite with traces of pearlite, and these are the modes, or occurrences, that the microscope reveals.

Constituents of Foundry Pig-Iron.

Foundry iron contains in varying percentages carbon, silicon, phosphorus, sulphur, manganese, and possibly traces of other metals such as titanium, also occluded gases. The fact that cast iron is such a variable compound makes it all the more difficult to control. The impurities, carbon, silicon and phosphorus, are more or less necessary for rendering the iron more liquid, and sustaining it in a molten state; also the varying contents of these elements alter the grain, grade and physical properties of the iron. Hence for foundry work, owing to the variety of castings produced which have so many differing conditions to fulfil, it is necessary to discover those mixtures which will be most beneficial for the kinds of work required, and to accomplish this often baffles the most experienced and scientific foundrymen, owing to the complex forms which the constituents take and the many factors which are not under control.

Carbon.—In foundry iron the carbon content varies from 3 to 4 per cent., the saturation point being about 5 per cent., but this will vary with the contents of silicon and manganese, a large percentage of either permitting the iron to carry or absorb more carbon. As stated, the carbon exists in two forms, combined and graphitic. In the former it is in combination with the iron, manganese and some of the metalloids, probably as a carbide, and is expressed as Fe_3C. In the latter it exists as free carbon.

White carbon contains only a trace of graphitic carbon, nearly the whole of the carbon being in the combined form. A No. 1 iron contains no combined carbon, or only a trace, the whole being in the graphitic form. It is important to note that the influence of the two carbons are in opposite directions, and to some extent the influences will be proportionate to the percentage of either. Combined carbon increases the susceptibility to chilling, and the contraction, hardness and stiffness, and lowers the melting point. Graphitic carbon decreases the susceptibility to chilling, the contraction and hardness, and raises the melting point.

Carbon existing as carbide has possibly more than one form; it is sometimes referred to as "free" and "dissolved" carbide. Graphitic carbon undoubtedly assumes many forms, known and unknown; if that were not so, the wide differences that exist in the physical properties of cast iron of the same analysis would long ago have been explained. The total carbon in molten iron is probably in combination with the iron and the metalloids, and separates out during cooling.

Silicon.—The content of silicon permissible in foundry iron is 3 per cent.; when that limit is exceeded, its influence is detrimental. The influence of silicon is to promote the formation of graphitic carbon. In that way it indirectly softens the iron—not by any virtue of its own, but by the formation of graphite plates, which break up the continuity of the structure. When above 3 per cent. silicon hardens the iron, but causes weakness and cold shortness, and if at the same time the total carbon is high, kishy iron is the result. For ordinary foundry iron 1.5 per cent. of silicon is most desirable. High silicon raises the melting point. It has a great affinity for oxygen, which may explain the fact that when the silicon and carbon contents are both high (both of which retard cooling), the surface of the metal when exposed to the atmosphere (as in a ladle) quickly sets and crusts, and throws off graphite carbon, while underneath the iron is at a dazzling white temperature. Apart from this occurrence, silicon promotes fluidity. Silicon combines with manganese and iron and exists a silicide of iron and manganese.

Phosphorus.—The phosphorus content varies in foundry iron from 0.25 to 1.75 per cent. The larger amount is chiefly found in iron made from Cleveland ironstone. Its greatest virtue is the fluidity it imparts, which favours clean iron. High-phosphorus iron is cold-short—almost brittle in thin sections. The phosphorus exists as phosphide of iron.

Sulphur.—Fortunately the content of sulphur is low in foundry iron. Its influence is to cause hardness when above 0.10 per cent. Although it lowers the melting point, the iron is dirty and inclined to be sluggish. Iron has a great affinity for sulphur and unites with it at red heat. The sulphur exists as sulphides of iron and manganese. Sulphur in-

creases the shrinkage and susceptibility to chilling, and promotes the formation of combined carbon.

Manganese.—Manganese is a metal of grey-white colour. It is hard and brittle, tends to cause the retention of the carbon in the combined state, forming a double carbide; hence, within limits, it increases strength and chill. It partially eliminates sulphur by combining with that element as manganous sulphide, which passes off as slag. Manganese sulphide is metallic.

The occluded and absorbed gases in cast iron (gases absorbed in the iron when molten and retained when solid) are oxygen, nitrogen and hydrogen. The other metals existing in traces in foundry iron are with rare exceptions infinitely small, and when required are mostly added in the form of ferro-alloys or special pig.

The foregoing is a very brief survey of the constituents of foundry iron as produced by the blast furnace. It will be observed that cast iron is a complex alloy of carbides, silicides, phosphides and sulphides, and in addition the numerous conditions of the carbon make it more complex still. Each melt and freeze at different temperatures, and it is often the case with the varying eutectics of the above solidifying at different temperatures that much trouble and difficulty arises in producing sound castings, when of very thick section, or of thick and thin sections combined.

Pulverised Coal as a Fuel for Metallurgical Furnaces.*

By H. R. Barnhurst.

Coal properly ground will burn thoroughly if 85 per cent. passes through 200 mesh and 95 per cent. through 100 mesh, the measuring screen apertures squaring $\frac{1}{\sqrt{200}}$ and $\frac{1}{\sqrt{100}}$ in, respectively. The term "properly ground" is used to express the condition that the coal thus pulverised shall contain a high percentage of ultimate fine dust practically unmeasurable. The author has found in such properly-ground coal a percentage above 70 capable of passing through 300-mesh screens, squaring $\frac{1}{\sqrt{300}}$ in. on the side. It may be presumed that these percentages progress relatively in the further reductions contained, as the larger screens, of course, pass all such fines without rejections. There appears to be no practicable means of measuring the highly-divided particles. As we can burn all the coal thus prepared, including the rejections when the percentages named pass the 200-mesh and 100-mesh screens, there seems to be no good reason for pushing pulverisation beyond this point. Coal can be cheaply brought to this condition and the mills able to do this work have large capacity. Higher percentages may be reached by the sacrifice of capacity and consequently economy. This standard of 85 per cent. through 200-mesh and 95 per cent. through 100-mesh is a practicable commercial standard and should be maintained.

Undoubtedly the proper method of firing pulverised coal is to admit with the fuel the exact quantity of air necessary to the result to be attained, as shown by observation, and to maintain the relationship between the fuel and air quantities so long as the conditions desired are being fulfilled. This matter of complete control of the two factors, fuel and air, is and will be at the root of all success with pulverised or sprayed fuel in metallurgical processes. Any air or oxygen supplied in excess of these requirements simply dilutes the products and lowers the temperature; also, insufficient air and oxygen will burn part of the fuel to CO_2 and part of it to CO, and with the air supply halved we obtain only the poisonous and inflammable CO.

It need not be supposed that an operator must be perpetually adjusting his apparatus. If we find that with the air-grate fixed at a certain opening the fire is too hot, a simple reduction in the quantity of fuel admitted lessens the source of heat and changes the ratio of the air to the fuel. If not hot enough, more fuel gives more heat units entering and a lessened excess of air, resulting in a heightened temperature. In all probability it will be found that excess air must be admitted constantly to keep the heat from reaching destructive limits. With control of both the quantity and quality of heat, this danger is negligible.

It must not be forgotten that an expansion of volume takes place in the air carrying the fuel as soon as it is heated. This expansion is of course based upon the related absolute temperatures and explains the large volume assumed by the flame on leaving the point of entrance. Excess air so carried partakes also of the expansion.

The temperatures usable cover a range of nearly 2,000 deg., or from about 2,000 deg. to 4,000 deg. By ordinary manipulation as described, the temperature and quantity of fire can be changed as easily as the turning on or off of a gas jet. The response is instantaneous. This particular feature renders the use of pulverised fuel particularly suitable in metallurgical furnaces.

The main difficulties in the earlier and experimental stages were caused by (1) not drying the coal; (2) poor pulverisation; (3) the carrying of too high temperatures; (4) the use of ports too small, giving the gases too high velocity.

With a knowledge of how much air is required with a given amount of fuel to produce a given temperature and a knowledge of the volume of gases so produced, it is easy to proportion the ports both of inlet and outlet so that a scouring blow-pipe effect may be avoided.

Aside from the advantages attainable in the higher efficiency of the fuel, there are a number of things which in actual service contribute to the profitableness of its use. The furnace begins its work almost instantly and with whatever degree of intensity may be desired. There are no periods of lowered temperature due to firing cold fuel.

In open-hearth practice with pulverised coal, steel is being made with this fuel at the rate of from 450 to 500 lbs. per net ton of product. This is an average of 45 heats, the fuel and product being carefully weighed. These figures were obtained during a continuous run of six weeks. The furnace was operating beautifully when visited by the author, and no mechanical difficulty had been experienced. The melts were obtained in slightly less time than with oil which had been used previously. Analyses of the slags produced with each fuel are as follows:—

	Oil.	Coal.
SiO_2	16.0	16.5
FeO	22.0	18.2
MnO	7.4	6.7
P_2O_5	1.7	1.9
Final analysis of the steel:		
Sulphur	0.025 to 0.035	0.035 to 0.04

Sulphur in coal, 1 to 1.15 per cent.

There appears here to be no more difference than would occur daily in the variations of the charge and of the fuel.

* Abstract of Paper read before the American Institute of Mining Engineers, and printed in the "Transactions" of the Institute.

Foundry Work from a Draughtsman's Point of View.*

By F. W. Hubble.

In considering this subject it is found that the average draughtsman takes such a small amount of interest in foundry work that it becomes necessary to consider the point of view that a draughtsman should take rather than the one he does. Quite a number of draughtsmen do not consider the foundry at all, or perhaps only consider it when a bad casting has been turned out; and then perhaps it is only for the purpose of recrimination. From the remarks which are sometimes made, one is induced to conclude that a casting with a high finish and correct to $\frac{1}{100}$ in. all over is the ideal thing from the drawing-office point of view. This is, of course, quite impossible in practice. But what should be demanded is a clean, sound casting, correctly shaped and within reasonable limits of the drawing sizes. It is impossible to closely define "reasonable limits," as each job must be judged on its own merits.

In the endeavour to cut down patternshop and foundry expenses, many people overlook the essentials of the matter, and particularly the faults that arise in the drawing office. The lack of foundry knowledge on the part of the average draughtsman is really immense. It has been many times proved

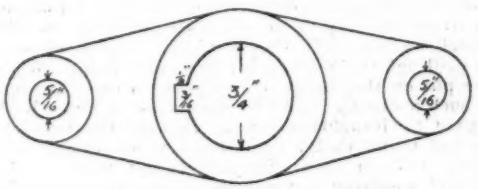


Fig 1.

that a draughtsman who has had a good machine-shop and fitting-shop experience is the man who makes the fewest errors in drawing, from the point of view of machining; and as a natural result it has become quite usual for a head draughtsman to insist on his assistants having a shop training. But, in no sense of the word can this apply to the foundry practice. Why such an important branch should be overlooked it is difficult to say, but the fact remains; and until it is altered, bad castings will also remain. The remedy is as open as that for overcoming machine and fitting-shops troubles. Why not apply the same treatment in the case of the foundry?

The writer can see no reason why the young draughtsman should not spend, say, one or two years, at least, on the foundry floor. Here he would meet the most common of the moulder's difficulties. But as this experience, good in itself, is not enough, it is necessary in order to get expert opinion first hand to keep in touch with the foundryman, and to invite his criticism of the drawing-office designs of castings. In the drawing office big alterations can be made by simply altering a line or so, and at the cost of minutes only. But the case is very different when the pattern and perhaps the castings too have been made. Alterations then become a matter of days and perhaps weeks, in addition to the waste of time and material.

Mention may now be made of some difficulties with castings which are unwarrantably incurred. The writer experienced one, with the casting shown in Fig. 1. The pattern was arranged for the keyway, the two $\frac{5}{16}$-in. holes, and the $\frac{3}{4}$-in. hole to be cored out. The holes and keyway were, of course, to be machined. Here the pattern-maker had put up the cost of the pattern at least 50 per cent. and the moulding cost another 20 per cent. From the machine-shop's point of view, the extra labour spent in coring the holes and keyway was valueless, as it was quite impossible to turn out this casting clean in the cores, they being filled, in fact, with a hard mixture of sand and metal, to the great detriment of the drills and slotting tools. Instead of assisting the job, this feature of the design only put up the cost.

Another point is with regard to machining allowances. On this point many managers will hold out against us. If machining allowances are too small, time is wasted in sharpening tools. With the more expensive metals, such as brass, gun-metal, phosphor-bronze, etc., there is a strong tendency to cut down machining allowances, with the object of saving that amount of metal on each casting. But too often to get this slight saving in weight of metal, first the pattern-maker is given extra trouble with his patterns, because shapes have to be made which in the ordinary way would be machined out of the plain shape; then the cost of machining goes up because the sand takes the edge off the tool, which must not go deep enough to escape it. Accordingly, the money saved by cutting down the weight is more than lost in the machine or pattern shop, with the net result that the actual cost of the finished article is raised instead of reduced. Again, the number of bad castings will also go up, because there is not enough allowance to take up any variation caused by slight differences in the position of the cores. In conclusion, the writer would advocate a better feeling between the shops and the drawing office, with a view to keeping down ultimate costs. If the drawing office won't give this extra time to their designs, then there must inevitably be wasted a lot of time in the patternshop and the foundry, and unless the patternshop is allowed to be fairly liberal with machining allowances, much valuable time will be lost in the machine shop.

Discussion.

The Chairman (Mr. J. Ellis), in opening the discussion, remarked that it had been said by some draughtsmen that they did not understand what the foundryman was talking about. He was of opinion that it was largely the fault of the foundryman that he was unable to dihcuss questions with the draughtsman. He (the chairman) agreed with Mr. Hubble that there should be greater co-operation between the foundryman and the draughtsman.

* Read before the London Branch of the British Foundrymen's Association.

Mr. H. C. Armin was of the opinion that there were not many firms who would allow their assistants to go through the foundry and then the machine shop. He advocated classes in foundry work for the draughtsman, as it was not feasible for him to devote the time during his drawing-office training. With regard to the sketch shown, if there was a quantity required of the work, he suggested that it would be better to core the centre hole and leave the rest blank to be drilled.

A Member disagreed with the suggestion that a lengthy experience in the foundry was practicable for the draughtsman. Even in the two years suggested, there was little hope of teaching more than the elements of foundry work. Moreover, it was not necessary for the draughtsman to be a competent foundryman, although he should have a sufficient knowledge of moulding practice to know whether a design was practicable or not from the moulder's standpoint. He (the speaker) would rather suggest a period of three months as a maximum, and that would just give time to become familiar with all the departments and their general procedure, while also giving some insight into the difficulties of a moulder's work. A longer period was not desirable, as the amount of ground to be covered in a five or six years' apprenticeship (even in only one branch of mechanical engineering), was so considerable that at the end of the period the young engineer would have only a tithe of the necessary knowledge. Since, however, metallurgy and a knowledge of materials was as essential to engineering design as to foundry work, a course of study in metallurgy was the best solution. That would greatly assist the draughtsman in appreciating the value of correct design and would at the same time form an essential part of his engineering training. Many of the engineering troubles that occurred were purely metallurgical questions, and that was why he (the speaker) suggested a study of metallurgy would be extremely valuable to the draughtsman. But as against the latter a very strong complaint might be made. There were hundreds of drawings turned out regularly which embodied considerable inaccuracies and were often hopelessly complex. If the foundryman was to be expected to read drawings, they should be made at least clear enough to be read by a draughtsman, which was more than could be said of many drawing-office products.

Mr. Aitken said he was very pleased to hear Mr. Hubble state that moulders should be conversant with drawings, and also that the draughtsman required a knowledge of foundry experience. But he thought that it would be better for the draughtsman to wait until he was a little older for his experience. The troubles of the foundry could only be appreciated by an older man. Mr. Hubble seemed to take his case from a moulder's opinion of the draughtsman. With regard to the sketch shown, it was, of course, possible that the cores were inserted to regulate the thickness of the metal and obtain a denser part. It was not always possible to consider the machine shop; the machine shop could be relieved of a little work to the detriment of the casting. The engineer often wanted something to his own advantage, but to the detriment of the moulder.

Mr. A. Willis said he did not think it would ever be possible for the draughtsman to acquire the technical knowledge that the moulder had. The moulder should know very much which was not required by the draughtsman. It would be better, he thought, for the draughtsman to consult the foreman moulder, when introducing a new design. The moulder was governed by fixed rules, such as contraction and the law of the crystallisation of metals. The difficulties he had to contend with were affected by the design of the casting he had to make. There were natural laws of which he had to take account; but the draughtsman's designs might clash with what the moulder knew to be scientifically correct. The draughtsman should not look for practical moulding experience, but should be in very close touch with the foundry foreman. The latter's claims should be primary and the shape and design of the pattern subordinated to the fact that the moulder's work was subject to fixed laws. He (the speaker) complained that the draughtsman did not take the trouble to think about the difficulties with which the moulder had to contend. The machine-shop man was in a far different position to the foundryman, as he had mechanical means for overcoming his difficulties, but the moulder had not.

Mr. D. Gordon said that since pattern-making and moulding were the fundamentals of engineering, they should not be ignored altogether in designing. With regard to the question of drawing, the draughtsman, as a rule, did not know anything about the laws of perspective; he had merely his three views. If he studied a little sketching from perspective he would be able to help the moulder considerably. The speaker referred to the complaint made by one member to the effect that the foundryman did not appreciate the possibilities of his own work. He (Mr. Gordon) thought that what the foundryman could not do with his core he could do with sand-paper and rasp. As far as the training of the draughtsman was concerned he should study both the foundry and the pattern shop.

Mr. A. R. Bartlett referred to the lecturer's remarks on variations in castings. He had found that was largely a matter of workmanship. Different moulders rammed quite differently and gave different castings. In regard to the casting shown in the sketch, at his works they would consider it cheaper to drill out the holes rather than core them. When one put on the charge of one penny a core, the cost of such a casting would be threepence higher. With regard to draughtsmen going through the foundry, he had found that a good many went through but never took a keen interest in the work. The method employed was for the apprentice draughtsman to take six months in the foundry, going through the departments. It was, he said, admitted that the moulder did not understand a lot of drawings; and he suggested that the moulder should learn more about drawing and the draughtsman a little more about foundry practice.

A Member said that he did not agree with the statement that the machineman could get over a lot of his difficulties by the scope he has with his machines. A great deal of trouble was also experienced in the machine shop by reason of castings not being true. He thought that there was a great difficulty in getting the draughtsman to properly understand the other part of the works. As to the question of designing, co-operation should be carried even as far as the man who had to put the casting in the jigs; every department, even the machine-shop, should be consulted when a drawing was being made. He suggested that it would be of considerable practical value to the draughtsman if he went to the pattern shop to see the results of the work of the pattern-maker, and then to the moulding shop to see one or two moulds.

Mr. Hubble, in replying, thanked the members for their criticism of his opinions, and thought he had learned a good deal. He said most of the points raised were answered by other members.

The meeting closed with a hearty vote of thanks accorded to the lecturer.

Snap-Flask, Plate, and Machine Moulding.*

By A. R. Bartlett.

Snap-Flask Moulding.

Moulding in snap-flasks is a much older practice than machine moulding, and is very extensively used in America, where the wooden box in all shapes and sizes is more widely adopted than in this country. Snap-flasks are not of great value where heavy work has to be done, nor yet where there is not sufficient repetition work to pay for the making of pattern plates. Any light work can be made in snap-flasks, but the usual practice is not to use them for general jobbing work, though their use saves floor space for storing boxes and also the cost of supplying the usual moulding box. The life of the snap-flask is considerable, as they are always made of hard wood, and as they should never be left on the floor, but hung up after using, they are not liable to get burnt or damaged.

In producing small castings in snap-flasks, either on the moulding machine or with plate moulding, a great deal of time and floor space is saved. Time is saved by having to handle only one pair of boxes, therefore not having to travel backwards and forwards from the stack of moulding boxes, as when ramming up in permanent boxes. The moulder rams first the bottom part, then the top part, loosens the pattern, lifts the top from the plate, then the plate from the bottom, assembles this mould, puts it in place on the pouring floor, releases the snaps, and returns with the empty boxes to repeat the operation. He has thus only to travel from the pouring floor to the plate, or machine, whichever he is engaged upon, with his empty snap-flask. Time is also saved in not having to stack the empty boxes when the castings are taken from the sand. Floor space is also saved, especially where machine moulding is done, for the reason that room is not required to stack the large number of boxes wanted in the ordinary way of machine moulding.

We have done a considerable amount of snap-flask work by apprentices with plates before the present moulding machines were installed, and the number of machines having now been increased, it is found much more economical to utilise for machine moulding the pattern plates the apprentices used with the snap flasks, by having the plates drilled for bolting to the machine table and to fit the machine box pins. But when the machines are busy we can always fall back on the snap-flasks. The pattern plates when used on the machine will have a longer life, as invariably the machines have a mechanical vibrator; if used for hand moulding, the plate gets distorted by the continual rapping and is liable to get broken by careless hammering.

Snap-flask moulding, as a general rule, must be confined to shallow work, on account of the risk of the mould bursting when poured, through having no supporting box. Deeper work can be made by banking sand against the sides and in between the closed moulds, or by placing the moulds in a trench and filling in around them. As a matter of course, all work made in snap-flasks must be weighted before pouring, and the usual way is to place a plate on the top of the closed mould, having a hole in it where the runner is located. The moulds could be clamped, but it would then be necessary to have plates on the bottom to match those on the top.

Multiple moulding is often done in snap-flasks, and then it is usual to clamp the work before pouring. But this work must of necessity be of a very shallow nature, and must not be very close to the outside of the mould, nor yet can it be carried very high on account of the strain put upon the bottom mould. In placing the moulds one on the other, a plate is placed under the bottom box, a pin passing from the plate through the lug of the boxes to top plate, the top plate on the first mould acting as the plate of the second mould, and so on. The height to which the work can be carried is, of course, decided by the class of work and the heat of the metal. In some foundries it is the practice to use loose iron frames inside the snap-flask to withstand the pressure, and then, of course, the height of the multiple moulds may be increased to whatever is practical for running purposes, and heavier work can be made as well. Any light work that can be made in a two-part box can be made in the snap-flask, providing proper care is taken and the pattern plates and boxes are in good condition.

The usual method of making pattern plates for snap-flask work is to mould the patterns in a box large enough to make the plate about 1 in. larger each way than the snap-flask to be used, this extra size being to ensure the moulder being able to rap the pattern plate without striking the box and loosening the mould. After the master patterns have been moulded in the correct positions to suit the snap-flask and the runners have been cut as they will be required on the plate to run the work when moulding in the snap-flask, a frame, the thickness and side of the plate required, is placed on the joint, and the sand then made up round it, this forming the joint for the top to rest upon. It is the practice in some foundries to place an iron frame on the joint to form the plate, this doing away with the labour of making up the mould for the plate; but if the pattern plate is made of cast-iron this is not advisable, as the edges of the plate are chilled, and are liable to get broken when loosening of the pattern takes place.

I do not consider the snap-flask to be of any value if a machine can be installed instead, for any mould that can be made from a plate in a snap-flask can be made on a moulding machine much quicker; and, in the case of the pattern having a flat surface, even if only one or two castings are wanted off, no matter whether it is cast flat side up or down, it can be placed loose on the moulding machine table and rammed much more evenly by the press-head than by hand in the snap-flask. Also, there is always the opportunity, with a machine table with holes in it, of screwing down the pattern, thus getting the benefit of an accurate draw; it is invariably found that the hand-drawn pattern moulded in the snap-flask leaves the mould in such a condition that patching is necessary.

* Read before the London Branch of the British Foundrymen's Association December 12, Mr. J. Ellis in the chair.

Plate Moulding.

Plate moulding is the first step from general jobbing moulding to machine moulding; but it needs a greater knowledge of foundry practice than the average machine moulder possesses. It is, accordingly, necessary to have skilled labour on it in a large number of cases. It can be done with small plates as in the snap-flask, or it can be enlarged upon to a very great extent, as in the manufacture of piano frames, filter press plates of a large size, and fly-wheels, etc.

Plate moulding does not lend itself to work of a deep description, as the usual method of lifting the moulding box from the pattern plate with large work is by the crane, and a good lift is not always managed by the sudden lift of the crane, no matter how carefully the box is steadied off. One method employed in lifting heavy boxes off the pattern plate is to use three or four small screw jacks. These are placed on solid foundations under the plate, and a hole is made in the plate to receive the head of the jack directly under the moulding box. When the box is ready for lifting, the jacks are operated so that the box lifts steadily from the plate, and a good lift is certain if all the jacks are worked in unison (see Fig. 1).

The usual method of vibrating the pattern is by striking a block of wood, held against the plate, with

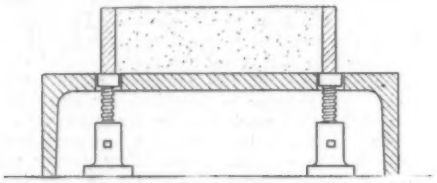


FIG. 1.—PATTERN-DRAWING ARRANGEMENT FOR HEAVY MOULDS.

a hammer; but a great improvement on this and in the result obtained, is to bolt a bar of mild steel of the shape shown in Fig. 2 against the side of the plate and strike on the bar in the middle of the bow, this having a springing effect and thus saving the direct blow on the plate and the possible distortion and damage caused thereby. The size of the bar would be decided by the size of the plate and the amount of loosening necessary to ensure a good lift.

In moulding a casting having both sides alike, it is only necessary to have a half-pattern, the bottom part being rammed and placed on the floor and the top part rammed and the mould closed. This method applies particularly to fly-wheels and castings similar to filter press plates. Some of the latter castings are a type of corrugated plate, having a large number of parallel ridges about a quarter of an inch high in

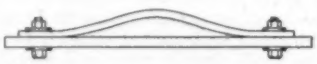


FIG. 2.—RAPPING PIECE.

sections, some running horizontally and some vertically across the plate. Some are studded all over with small cubes resembling hobnails. Since there is no vibration during the actual lifting of the moulding box as in machine moulding, it is absolutely necessary that a good tough facing sand be used to ensure a good lift, and so avoid the necessity of mending the broken parts entailed by a bad lift. On all large plate moulding we use a base of Mansfield sand.

Another type of work done on plates is the making of pipes, spindles, or any description of round casting. Any of these moulds lift clean and perfect from half-patterns fixed to a plate, and if flanges are used on them they can be worked loose and drawn out after the mould is lifted. The same applies to any lug or boss that can be dovetailed or pinned until the ramming is done, the pins being then withdrawn so that the loose pieces lift with the mould. This idea has been improved upon by having the half-pattern made in iron and revolving in a bearing, so that when the mould is rammed and ready for lifting, the half-pattern is turned by a handle from the outside of the plate (see Figs. 3 to 6). The plate itself is made as

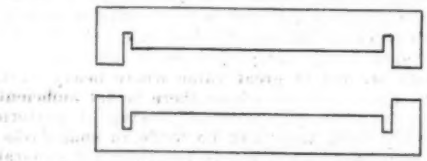


FIG. 3.—STRIPPING PLATE FOR PIPE MOULD.

shown in Fig. 3 when for a pipe, the hole in it being the exact size of the casting required. A frame is made for the plate to stand upon, the plate being bolted on so that another can take its place when required. The frame (Fig. 4) remains stationary. The

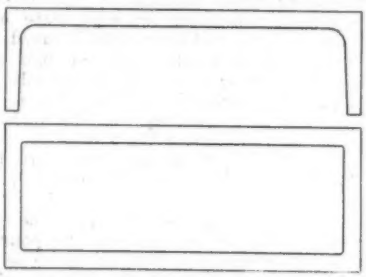


FIG. 4.—SIDE ELEVATION AND PLAN OF FRAME.

pattern itself is made as shown in Fig. 5. It is held in its place by a cap placed outside the box, and the end extending beyond the plate is made square to receive the handle. When the mould is rammed, the pattern can be turned clear of the mould, making it impossible to get a bad lift, as there is only a flat surface to lift from, and a reasonable quantity of parting material will avoid any sticking of the sand. Only unskilled labour is employed ramming this type of work, but it is expedient to employ skilled labour to

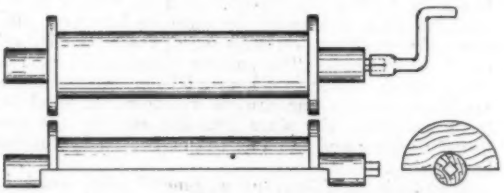


FIG. 5. PLAN, SIDE ELEVATION AND END VIEW OF PIPE PATTERN.

core and close the moulds. No tooling of the mould is necessary, as the turning of the polished pattern sleeks the mould, thus doing away with the moulders' tools, and saving a great amount of time.

Certain types of sheaves can be made on the same principle, also worms if a screw is placed in the bear-

ing to correspond with the screw on the pattern. A practical man can adapt this method of moulding to a great number and variety of circular castings if the opportunity occurs. No doubt all plate moulding could be machine moulded, and the mechanical drawing of the pattern would often save knocking out a box and ramming it up again; also, if it were rammed by power instead of by hand, a much better result would be obtained, on account of the even ramming.

It is only necessary to put half the number of patterns on a plate to the number of castings required in the mould if there is a flat back to the work and tooling is not called for on the face; they are arranged so as to clear one another when the top part is put upon the bottom (as shown in Fig. 7), half the castings being in the top and the other half being in the bottom. This will, of course, apply to any plate, whether machine moulded or otherwise.

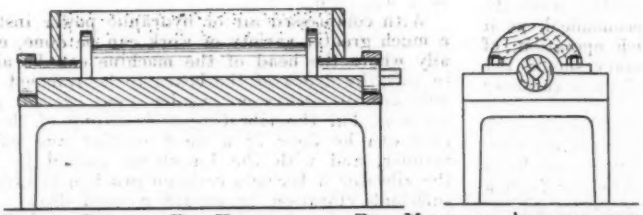


FIG. 6.—SIDE AND END ELEVATIONS OF PIPE-MOULDING ARRANGEMENT.

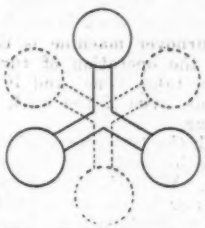


FIG. 7.—MOULDING SIX CASTINGS FROM THREE PATTERNS.

Machine Moulding.

A few years ago the moulding machine was considered a luxury in the foundry; now it is looked upon by most metal founders as a necessity. The opposition of the skilled moulder to the moulding machine a few years ago was very keen, but that is now passing away, for he sees that a cheap production of repetition work is relieving him of the monotony of the one job and placing larger and more intricate work in his hands than was formerly the case; for the more delicate and intricate work is not always adapted for machine moulding. There are a great number of moulding machines that demand the services of the skilled moulder to work them, as well as to follow the unskilled workman after he has rammed the work, whether by hand or power, to place the cores in position, and take the vents off in a proper manner. But the greatest economy is made on work of a simple enough character to be entirely handled and closed by the unskilled workman, *i.e.*, the average foundry labourer.

On account of the rough usage all tools in the foundry have to stand, and the sand which is liable to get into the working parts of the machine, it is advisable to consider the durability and the simpleness of the machine before installing one. The machine that will require the services of a fitter in the event of its getting out of order will be an expensive tool. In all moulding it is necessary that the moulds be hard enough to withstand the pressure of the metal and also be porous enough to let the gases generated by the hot metal escape, so as to avoid blowing and scabbing. If the right mixture of sand is used, the machine moulder can make a much better casting after he has learned to use his machine than can be produced by hand moulding.

The classes of castings that can be made on the moulding machine depend greatly on the ingenuity of the foundry foreman and his opportunity of getting the pattern-maker to make his pattern in the right way for machine moulding. The indifference of the management may limit the output of a machine, or too much enthusiasm may cause one to go beyond the bounds of possibilities. But it is safe to infer that all castings that can be made in a two-parted box can be successfully made on the moulding machine.

Among the advantages which machine moulding has over hand moulding are greater output and greater accuracy and uniformity in shape and size. For castings that have to be machined, this latter is an important item, as the tooling is done at a regular rate and time and expense saved in the machine shop. Also a much better finish is given to machine-made castings. There are no heavy fins to chip off, the perfect fitting of the boxes and the perfect drawing of the pattern doing away with tooling and mending up of the mould, which in hand-moulding often causes bad joints and bad castings. Also, the cost of trimming is greatly reduced, as machine-made castings, if placed in a rattler, need no trimming whatever, only an emery wheel being needed to grind off the projecting end of a runner or riser.

There is hardly a limit to the size of work that can be made on moulding machines. Very small work can be most successfully done, also large work on machines made for that purpose. Of course, all boxes and patterns must be accurate and must be kept in a state of perfect efficiency to ensure good results continually.

Before purchasing a moulding machine it is necessary to consider what type of machine is best adapted for the work to be done. It must not be thought that any machine will do any and every job. Also, it is impossible to run a general foundry with moulding machines only. In selecting a machine it is necessary to consider how many different castings can be made on any one machine, and then consider what would be the cost of working the machine, and whether any excess of power that is running to waste in the shape of compressed air or hydraulic power could be utilised for operating it. The adoption of machine moulding has caused great changes, not only in moulding, but in pattern-making also. For with the patterns for machine moulding being made of metal or hard wood, and not getting broken with the rammer, and with the equal ramming given by the press-head or the jar rammer, the need of venting done away with to a large extent, the patterns do not get broken or spoilt with the vent wire; and the loosening bar not having to be used or holes made in the pattern for drawing, the damage to patterns is much less.

Where possible it is advisable to ram bottom parts and top parts alternately, for in so doing the moulds can be closed at once, and if cores are to be placed in position they invariably go to the bottom part. This often saves the need of cleaning the moulds of dust and loose sand that will find its way into an open mould, and the necessary mending if anything should fall into it while waiting for the top parts.

The drawing of the patterns from the mould differs in the various types of machines, some lifting or lowering the mould from the pattern plate which remains fixed to the machine, and some drawing the pattern, while the mould remains stationary as in hand moulding. With machine-drawn patterns it is not so needful to have as much taper as would be necessary with the same pattern if hand-moulded. But if the pattern is undercut, no amount of vibration will ensure a good draw on the machine; so it follows that all patterns for machine work must be properly made. An undercut pattern can be made to do if hand moulded, but at the expense of severe loosening and consequent damage. Every type of machine has its adherents. One man will advocate the turnover machine; another will not see the necessity for the turnover. This is to a very great extent dependent on what class of work is required. For shallow work the non-turnover machine is the most economical, as it saves the operation of turning, which operation, of course, takes time, and if not necessary should not be done, even if the work is rammed on a turnover machine.

With the turnover machine the more intricate work can be lowered from the pattern in a perfect condition. Work having deep internal parts, such as pulleys or boxes, are turned out much better from a turnover machine than from a non-turnover machine. With the turnover machine the mould is in the right position for placing on the floor as regards the bottom part, and this often saves irons or gaggers in deep work, as there is no fear of the deep parts falling off, which is likely to happen in the non-turnover if no gaggers are used. As regards the top parts, it is essential that the same work should be done on both machines on deep work, as in both instances the deep or hanging part has to be made secure to prevent falling off when placing the top part on the bottom.

For deep work the jar-ramming machine is undoubtedly the best, as there is no need to hand-ram any part, as would have to be done on a press-head machine. With the jar-rammer the ramming is hardest where it is most essential that the mould should be sound to withstand the strain of the metal and also on the joint. The mould is also rammed evenly, whereas if a hand rammer is used to ram round the deep parts of the pattern, the latter is always liable to get hit and damaged.

The machine fitted with a stripping plate is a very useful type of machine for large pulleys or tooth wheels having straight teeth. The pattern is drawn down, or up through the plate, which supports the sand on the edge of the mould, thus ensuring a perfect lift or draw when the mould is taken from the machine. This, no doubt, is an expensive machine, as every size of wheel must have its own stripping plate. Knowing how difficult it is to get a perfect draw by hand when moulding a spur-wheel pattern, and how slowly a badly-drawn mould is mended, it is obvious that a machine for this work is very economical if there is sufficient work to justify the outlay necessary.

The different machines on the market are so varied that every metal founder has the opportunity of getting a machine best adapted to his requirements with very little trouble. There is the wheel-moulding machine for those who are making a quantity of spur wheels, no matter what type of tooth is required, whether for helical, straight, or flanged wheels, and up to almost any size. On this machine great care has to be taken in fixing the diameters, and experience is necessary to ensure a good result. There are also many types of hand-power press-head machines for small repetition work, giving rapid and economical production; also the hand-ramming machine for deeper work, which can be operated by unskilled labour after a very little tuition.

At first sight it does not appear that much saving of time can be effected on a hand-ramming machine. But when consideration is given to the fact that the patterns are drawn perfectly true and that the mould does not need patching and tooling, as in the usual jobbing moulding, then it is realised what a great economy is effected on the machine from this aspect only. The remark is often made that a hand-ramming moulding machine is only half a machine; but four or five times the amount of work can be turned out per day that a skilled moulder will do, and the credit must be due to the perfect drawing of the pattern and the saving of time effected thereby. These machines are in great demand where no power is available, and are often more economical to small founders if they can do the work required, as the cost of installing compressed-air or hydraulic power is a big item.

With compressed air or hydraulic power installed, a much greater variety of work can be done, especially where the head of the machine can be altered to suit the depth of the boxes to be rammed. Not only can perfect ramming be done by the power machine, but the vibrating or loosening of the pattern can be done in a most regular and efficient manner, and with the knowledge gained in using the vibrator it becomes common practice to give just sufficient vibration to ensure a good draw. Too much vibration is liable to cause the work to fall out when lifted from the machine. With power machines of this type it always follows that the sand is rammed hardest close to the pattern and the box, on account of the resistance offered by them, leaving the sand between these two points in a more open condition, thus helping to vent the mould and leaving an open passage for the gases to escape. This avoids the necessity of the venting which would have to be done on hand-rammed work, where the hardest ramming is usually in between the pattern and the box.

A machine that will do deep work very effectively is the combined jolt-ramming and press-head turnover machine. The moulds made on this are mainly rammed by jolting. The press head being used to ram the loose sand left on top of the box after jolt ramming. The machine is rapid in its work, and is adaptable to shallow as well as deep work. The number of jolts needful to ram each job being decided by what strain is put on the work when pouring and the weight of the casting required, shallow work requiring less jolting than deep work. The method of working this machine is to fill the box with sand, placing any irons in position, no matter what depth the box may be, give it the required number of jolts, bring the press-head down on top of the loose sand, then strike off the superfluous sand. The box is clamped to the turnover table, which is then turned by power and lowered to the drawing-off plate. Attached to this plate are 4 iron wedges, which are put into position under the box all together by means of a lever, thus ensuring the box being parallel to the pattern plate when drawn.

Jolt-ramming machines are greatly in use for large and deep moulds, the machines doing ramming only; but a large amount of time is saved, very large work being rammed in a few minutes which, by the usual method of hand-ramming, would take two men a day or more. As with the small combined machine before mentioned, the sand and necessary irons, grids, or gaggers are placed in position; the jolt table is then operated by opening a valve, and when the required number of blows have been given the valve is closed and the top of the sand flat-rammed by hand. It is not necessary to fix the pattern plate to the jolt table, but it must be so placed above it that the weight of the work to be rammed must be evenly balanced. The pattern plate is usually a flat one, the ordinary wooden pattern being placed in

the necessary position on it to suit the box, then the box is clamped or bolted to it. When rammed they are lifted off and turned over. The pattern is then drawn by hand and the mould finished in the usual way. The pattern must be flat next to the plate, this necessitating the pattern being made in two when it is not a flat job. Some machines of this type have a pattern-drawing mechanism attached to them.

Large cores are sometimes rammed on the jolt machine, and then turned out in the ordinary way. I believe a jolt rammer has been installed in Belfast capable of ramming a weight of 15 tons. All patterns for this type of machine should have no overhanging parts, as the sand would be held up by them. Any side extensions of the pattern that do not touch the pattern plate, or would want a draw-back or sloping joint to get them out in the ordinary way of moulding, must be printed and cores made to form the desired shape. All work rammed on the jolt machine is so evenly rammed that the vent wire is very seldom used. The machines are of various sizes and power, some giving a 3 in. and some a 3 ft. jolt, working at a capacity of about 80 lbs. The tables on them range from about 15 in. square to about 8 ft. by 12 ft. or thereabouts. The pattern plates can extend beyond the table if they are made rigid enough to take the weight of the mould and the blow given. The small size mentioned will ram a weight of about 300 lbs.; the larger they are made the more weight they will ram, the mechanism being made in proportion.

Discussion.

The CHAIRMAN (Mr. J. Ellis), in opening the discussion, said the subject dealt with was a very wide and important one, upon which much might be said. He would remark that, regarding a criticism of the snap-flask, there was now obtainable an attachment whereby the pins were properly centred and a good joint obtained.

MR. AITKEN asked whether it was necessary to have a heavy box for use on a jar-ramming machine?

A MEMBER referred to certain unsuccessful attempts to operate economically an old design of boxless machine, using steam. He had worked multiple moulding successfully with snap-flasks but found that the best results were got with three moulds high, which practice saved one box in three; a steel band was found convenient for preventing bursting out, and the moulds were poured gently.

MR. DELELANDE mentioned an example of machine-moulding in France where labourers were making moulds for six-cylinder crank cases as well as moulders could do.

MR. PEMBERTON considered that the future of moulding in this country was dependent on the machines. In regard to a damaged mould made on a machine, it was generally simpler to knock out the mould and make another than to attempt to repair it. The skilled moulder would never be dispensed with by the use of machines; he was wanted for coring up and closing; beside which, there were scores of moulds that could never be made on a machine.

MR. BARTLETT, in reply, to the discussion, remarked that all the work in his shop was cored and closed by the moulders. Jar-ramming would not require heavier boxes than other machine moulding; very heavy jobs, of course, required more blows and put a greater strain on the boxes. Good patterns were essential if labourers were to operate moulding machines. In regard to moulding boxes, these would have a longer life on machines than with hand-moulding; there would, of course, be a tendency to get out of order, through pins and holes wearing, but the holes could be drilled out and bushed.

MR. WOODS, in thanking the lecturer for his Paper, made some interesting remarks on the use of the moulding machine and the difficulties that had been encountered in the past with its introduction.

"F.T.J." Bookshelf.

Foundry Machinery.

By E. Treiber. Translated and revised by Charles Salter. London: Scott, Greenwood & Son, 8, Broadway, Ludgate, E.C.

This little book of 135 pages is devoted entirely to the machinery and equipment of foundries, though in the space occupied it is impossible to deal in great detail with any plant. The book surveys the various classes of machinery used in foundry operations and their application, as adapted to English practice. The uses and manipulation of the apparatus rather than the mechanical construction come under consideration. The classes of machinery included are as follows:—Machines for the preparatory treatment of moulding material; pig-iron breakers; moulding machines, including hand moulding machines, simple lift-up machines, turnover plate machines, moulding presses, moulding presses with double pattern-plate, machines working without boxes, jig moulding machines and allied types, and special moulding machines; core moulding machines; pneumatic rammers; fettling machines; and hoisting and conveying appliances. While only really summarising the question of foundry machinery, the book clearly shows in what direction many foundries could effect economy by installing machinery.

Molesworth's Pocket Book of Engineering Formulæ

Published by E. & F. N. Spon, Limited, 57, Haymarket, London, S.W.

Since the first edition of this pocket-book was issued 50 years ago, it has steadily established a position among engineering reference works which is almost unique. There is probably not an engineer of any standing who is not familiar with its usefulness and importance; and it may safely be said that the present, or twenty-seventh edition, will be very well received. This pocket-book, which occupies over 940 pages and contains 800 illustrations, is a compilation of useful formulæ and memoranda for civil, mechanical and electrical engineers, by Sir Guilford L. Molesworth, K.C.I.E. (Past-President of the Institution of Civil Engineers, etc.), and Henry Bridges Molesworth, M.Inst.C.E., with an electrical supplement by Walter H. Molesworth, M.I.E.E., M.I.Mech.E. The development of engineering which has taken place during the life of this book has been a development from infancy to maturity, and with each step in progress the book has kept pace. It is not surprising, then, that the present edition also has been revised considerably and enlarged. In its revised form it will continue to receive the keen appreciation of the engineering world.

The "Mechanical World" Electrical Pocket Book for 1914.

Manchester: Emmott & Company, Limited, 65, King Street.

This little pocket book follows on the same lines as the previous editions, but contains several additions. It appears to have been brought well up-to-date.

D

Foundry Sands and their Treatment.

By Algernon Lewin Curtis, M.E.

(*Continued from page 782.*)

For taking micro-photographs like those shown in the previous figures, where the microscope must be kept in a vertical position, the author has found that the instantaneous reflex camera shown in Fig. 25 (made by Wm. Watson & Sons, Limited) answers every requirement. This camera which is mounted on four legs has a square mahogany body with bellows extending to a length of 10 in. On one side of the body is a ground-glass observing screen, the image of the object being reflected on to this by means of a surface silvered mirror attached to the underside of a shutter set at an angle of 45 deg.

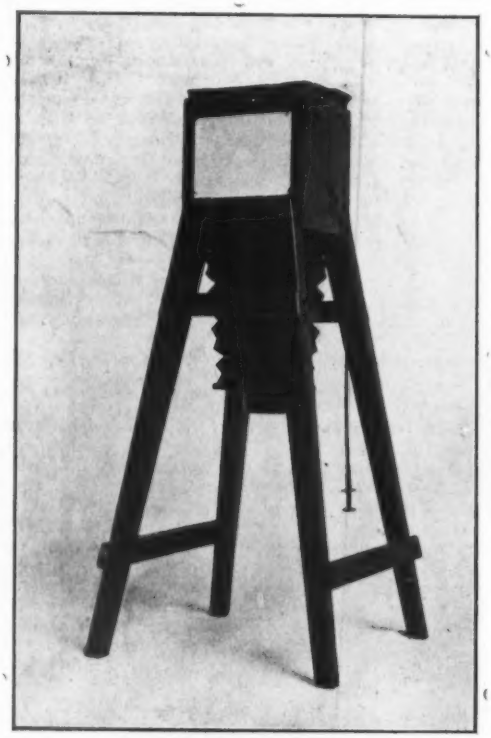


FIG. 25.—REFLEX CAMERA.

in the interior of camera. Instantaneous or time exposures are made by actuating a release, the observing screen being simultaneously closed.

In addition to the camera and microscope with its usual equipment of objectives, the following accessories should be used :—

(1) A projection eyepiece. This eyepiece can be used advantageously with objectives of either the apochromatic or ordinary series for photographic purposes, these projecting a very sharp image of the object on the screen. A diaphragm between the lenses limits the field, and a sharp image can be made to appear on the screen by adjustment. This latter is effected by revolving the cap of the eyepiece in its spiral slot, so that the eye or top lens is brought closer or farther away from the diaphragm, as may be required, and divisions with a reader are provided for registering such positions.

(2) A bull's-eye condenser, preferably of the aplanic type with an iris diaphragm attached (see Fig. 26). It is frequently found that the most minute alteration of the position of the bull's-eye condenser is necessary, and with this piece of apparatus the difficulty of fine adjustment is removed.

(3) A suitable illuminant. As mentioned in previous chapters a portable incandescent gas lamp will be found preferable to any other source of illumination.

(4) A pair of light-tight connecting flanges for connecting the camera with the microscope.

(5) A focussing lens for focussing the image on the screen of the camera.

(6) A set of colour screens or light filters.

In order to get the best definition an Abbe illuminator should be used in the microscope, and connected to it an iris diaphragm, besides a fitting for carrying coloured glasses or light filters.

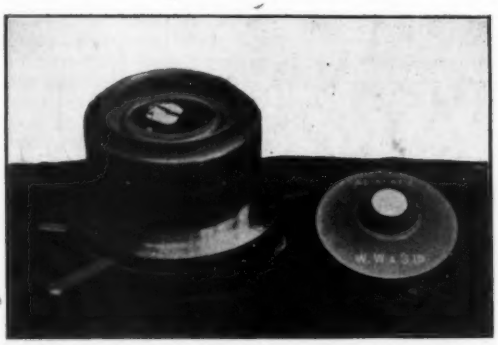


FIG. 26.—BULL'S-EYE CONDENSER WITH IRIS DIAPHRAGM.

The following may be of assistance to founders wishing to take their own microphotographs of moulding sands or materials. First procure a piece of glazed cardboard about 6-in. square in order that the lighting and image from the microscope may fall upon it to enable what is going on to be seen clearly. Next set up the instrument in a perfectly vertical position, having previously attached the mechanical stage. Place the slide in the clips of the stage, so that a good average sample of the material can be obtained. Light the incandescent gas lamp, replacing coloured glasses to make the illuminant as near daylight as possible, then set the bull's-eye condenser with it (this latter only applies to mounted specimens, and not to test pieces requiring top illumination) and in a position to give parallel rays. The distance the condenser should be placed from the lamp, of course, varies, but generally should be from 1½ in. to 3 in. Insert the projection eyepiece in the connecting flange and fit into the body tube of the microscope, then place the camera so the flange attached to the latter's bellows drops centrally into the flange of this instrument. The mirror is

then turned up in the camera by a thumb-screw placed at the operator's right hand until it clicks. It is necessary that the parallel beam of light falls centrally on to the iris diaphragm at the bottom of the Abbe illuminator. Adjust the position of the centring, both of the light and the bull's-eye until this is attained. The square piece of cardboard can be interposed between the bull's-eye and substage condenser to ascertain whether the desired illumination is produced. This having been properly done, the card is now placed 6 in. or 8 in. beyond the eye-piece, and the object focussed sharply upon the card. The iris diaphragm attached to the bull's-eye condenser is treated as the source of light and should be closed down accordingly. If the Abbe illuminator be racked to or from the stage very slightly, the image of the central aperture of the iris diaphragm fitted to bull's-eye condenser will be seen in focus in the disc on cardboard. It probably will not be quite central at first, but this can be corrected by using the adjusting screws provided on the bull's-eye until the centre of its diaphragm corresponds with the centre of the projected disc. This centring having been carefully done, the iris diaphragm of the bull's-eye should be opened until it illuminates the projected disc to its margin and no more. A sharp edge to the disc can be produced by turning the adjusting collar of the projecting eye-piece. If all these adjustments are carefully made, an evenly-illuminated disc will result, and the slide can be focussed on the screen. It is a good thing to cement a No. 2 cover glass on the ground glass-side of the screen of the camera, using balsam in benzol, for purposes of focussing.

After arranging the microscope and camera, and having accurately adjusted the optical system, it is necessary to determine the amount of exposure for the purpose of getting a sharp well-defined negative. It will be obvious that this is no easy matter, and definite rules or times cannot be given here, as the greatly-varying colour and density of moulding sands or materials can only be determined by experience. Exposures are generally, however, governed by (*a*) the number of diameters the object is desired to be magnified, (*b*) the relative speed of the plate, and (*c*) the relative actinic value of the illuminant used. There are other factors which should also be taken into consideration, viz., colour and density of object and value of colour screen used, but this latter is usually governed by the former.

Exposures may be termed correct when a sufficient light action has taken place in parts of the projected image in which there is no light obstruction. This is based on the assumption that a non-coloured object is in the microscope which is delineated entirely by a perfectly transparent and opaque area. There is an appliance on the market for estimating the relative intensity of illumination at the focussing screen, viz., that suggested by Dr. Bousfield, and termed a sensitometer; but it is best for the foundryman to determine by experience the time of exposure necessary to give the best results. There are many systems advocated for exposure, and almost each branch of microphotography has its own formula. For moulding sands and materials when mounted, the author has found that when using an Abbe illuminator, a yellow screen placed on the projection eye-piece gives excellent results for depth and definition if rapid plates and fairly long exposures are adopted. It must not be forgotten that the speed of the plate will within wide limits influence the term of exposure, but it is wise to adopt one make of plate and keep to that make altogether on this particular branch of work. An under-exposed plate is useless and cannot be used, but an over-exposed plate can be suitably developed and turned into a good negative. It is well to have access to the different plates by the same maker, as a faster or slower plate may be better suited for a particular specimen.

In ordinary photographic work there are a number of processes available, but with microphotographic work where the artistic side has not to be considered, only two processes need be used, (*a*) daylight printing on gelatine or collodio-chloride paper; and (*b*) artificial-light printing on bromide paper. These methods give a print in which the image is on the surface and not in its depth, so the greatest amount of detail can be brought out.

The method of artificial-light printing on bromide paper is usually preferred for micro-photographic work in making rapid diagnoses of moulding materials, though the foundryman should accustom himself to reading a micro-negative. In other words, if a mould for a large and important casting is being made, it is desirable to test the facing sand of the mould before pouring. Test pieces can be made of the sand, placed under the blowpipe, then photographed under the microscope, all in an hour or so, and proof obtained by a negative of the value of the sand used. When the foundryman has ample time at his disposal, daylight paper will be found best, as it gives a better idea of the nature of physical changes in such materials. Of course, the choice of a rapid or slow paper depends upon the negative, as it is possible to obtain a much brighter and harder print from a weak negative by using a slow bromide paper than one of a rapid nature.

Artificial printing is carried out by exposing the negative to any suitable artificial source of light. An incandescent gas flame may be used for this purpose, but in order to obtain good results some arrangement should be made for exposing prints at correct distances from the light source. With ordinary illumination the light action will vary as the square of the distance. From 18 to 24 in. will be found a suitable distance to expose negatives of moulding sands or materials. Time of exposure necessary, of course, varies with the density of negative, source of light, and distance negative is placed from it, besides the rapidity of the paper. The author's experience, however, has been that from 1 to 10 seconds at 24 in. from source of light gives very good results, the difference between 1 and 10 seconds depending upon density of negative. Perhaps the most practical method is to make two prints of a negative, giving each a different exposure. A little practice, however, in this direction will teach the foundryman how to judge the correct exposures.

(To be continued.)

Open-Hearth Production Record.

A new record for a month's production was made in the United States recently by two stationary open-hearth furnaces, Nos. 5 and 6, of the Youngstown Sheet and Tube Company, Youngstown, Ohio. The tonnage produced and the number of turns operated in the month by each of this company's six furnaces are tabulated below :—

Furnace.	Turns operated.	Tons of ingots produced.
No. 1. Pipe-cooled ports ..	49	5,030.5
No. 2. Pipe-cooled ports ..	34	2,944
No. 3. Pipe-cooled ports ..	57	5,397
No. 4. Pipe-cooled ports ..	55	4,972
No. 5. Blair ports	58	6,090.9
No. 6. Blair ports	58	6,213.8
Total	.. ..	30,648.2

No hot metal was available, the entire production being made from cold pig and scrap.

Manganese Brass.

By A. Napier.

Under the title of manganese bronze there is known to the engineering world an alloy which possesses considerable interest from the foundry standpoint, first because of its high tensile strength and, second, because of the difficulty experienced in obtaining its best qualities in a casting.

Before proceeding further, however, it may be stated that the alloy in question is certainly not a bronze in the strict sense of the term; it is essentially a brass with additions of manganese and other metals. Manganese bronzes proper, or copper-tin-manganese alloys, find relatively little application in engineering. When other elements (particularly zinc, which is an important constituent of manganese brass) are absent, the copper content of true manganese bronze is usually about 80 per cent., and the manganese content in the casting is very small and variable, since it acts as a deoxidiser, and is thus largely eliminated, though serving a useful purpose. The tensile strength of such an alloy is fairly high, and another noticeable feature is the considerable resistance to corrosion in sea water. While it is often stated that manganese bronze is used for screw propellors, gearing and various machinery parts, most of the alloys in question are manganese brasses, having considerable amounts of zinc in their composition, and lead in addition. One alloy, however, which might be termed a lead bronze, and which is acid-resisting and suitable for bearings, may here be mentioned. It has the composition of about 73 per cent. copper, 21 per cent. lead, 5 per cent. tin, and 1 per cent. manganese-copper.

As regards the copper-tin-manganese alloys, Guillet found that varying percentages of manganese had the influence indicated in the following table:—

Copper.	Tin	Manganese.	Tensile strength.	Elastic limit.	Elongation on 4 in.
Per cent.	Per cent.	Per cent.	Tons sq. in.	Tons sq. in.	Per cent.
90.93	8.82	0	15.6	5.9	23
90.12	9.20	Trace	17.1	5.7	28
87.64	10.41	1.67	13.6	6.4	20
89.38	8.61	0.69	10.4	6.2	7.5
85.87	8.76	3.10	7.5	7.5	0

These results would indicate that when present in more than traces manganese causes brittleness, and this is the usual effect in the absence of zinc, which element is accordingly added in amounts varying from 4 per cent. upwards.

Composition of Manganese Brass.

As typical of manganese-brass composition may be quoted a proposed specification submitted in 1911 to the American Society for Testing Materials. The chemical composition of the ingot metal was given as:—

	Per cent.
Copper	55 to 60
Zinc	39 to 45
Tin, not over	2
Aluminium, not over	0.5
Manganese, not over	0.5
Iron, not over	2

The tensile strength was stipulated to be not less than 70,000 lbs. (about 31 tons) per sq. in., and the elongation not less than 20 per cent. on 2 in., the standard turned specimen for the tests to be 0.5 in. diameter.

Other compositions quoted by different authorities are as follows:—

	1.	2.	3.	4.	5.	6.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Copper	54.00	57.4	51.5	56.57	54.11	58
Zinc	40.00	37.0	42.0	40.50	43.34	40
Tin	2.25	0.3	1.0	1.21	0.75	—
Aluminium	—	0.3	0.5	0.14	0.47	1
Manganese	3.75	—	—	0.07	0.01	1
Iron	—	—	1.0	1.50	1.30	—
Lead	—	—	—	0.01	0.02	—
30 % Mn-Cu	—	5.0	4.0	—	—	—

With elements having such different melting points as manganese (1,245 deg. C.) and zinc (419 deg. C.) or tin (232 deg. C.), the first alloying requires to be done somewhat carefully. The whole obviously must not be raised to a point which will allow the manganese to alloy, so that element is first introduced into part of the molten copper; but since in ordinary foundry practice the use of metallic manganese would generally involve overheating the copper, it is best to employ cupro-manganese (obtainable commercially with about 30 per cent. Mn.), using sufficient to get the desired composition. Ferro-manganese also may be used, and is indeed employed by many founders who desire to include iron in the final composition. In other cases the iron is introduced in the form of tinplate clippings. A formula which introduces iron in that way and gives the composition of alloy No. 4 in the above table is as follows:—Melt under charcoal 26 lbs. of copper and gradually add 1 lb. of tinplate clipping in small pieces; when these are melted, add 22 lbs. of zinc previously heated and 1 lb. of tin; stir thoroughly and pour into ingots. Then melt 26 lbs. of copper under charcoal, add 4 lbs. of 30 per cent. manganese-copper and 20 lbs. of zinc, and pour into ingots. The alloy is formed by melting together 49½ lbs. of the first alloy and 50 lbs. of the second, and adding 8 oz. of aluminium. The metal is then melted twice in order to mix it thoroughly. If desired the first alloy may be added to the second while it is molten instead of pouring into ingots.

There is no doubt that the success of such an alloy is greatly dependent in the first place on thorough mixing, and this is not easy to effect when metals of such different specific gravities are brought together. Further, the melting should be done as quickly as possible in order that the composition of the alloy may not be materially altered. Volatilisation of zinc is the first trouble in this direction, and so liable is it to occur that some makers of the ingot alloy advise the addition of 2 lbs. of zinc to each 100 lbs. of the brass on remelting. Prolonged melting also involves a liability of the iron, when included, to oxidise, which causes a reduction in both strength and ductility and also a rough black surface on the metal after casting. The presence of the manganese, of course, to some extent corrects the oxidation of copper and iron, but even then the oxides are not all

removed from the metal, but remain entangled and lower its quality. On this account the writer doubts the advisability of repeated melting to secure proper mixing, as is advised by some users. If volatilisation and oxidation could be securely guarded against, the case would be different, and remelting would have only a beneficial influence, but that is not practicable in ordinary foundry work. Each remelting increases the danger of changed composition and decreased strength, so it would seem advisable to mix as thoroughly as possible when making an alloy rather than remelt for that purpose. Apropos of that may be quoted the experiments of Mr. Jesse L. Jones* to ascertain the effect of repeated remelting of manganese "bronze," without the addition of zinc, etc., to the heats. Some of the results were as follows:—

	Heat number.	Ultimate strength lbs. per sq. inch.	Elongation on 2 in. per cent.	Reduction of area per cent.	Electrical conductivity.	Hardness (Shore).
Crucible furnace.	1	76,850	22.5	21.5	24.10	23.3
	2	69,700	43.0	51.0	21.75	19.4
	3	66,750	45.0	55.0	20.82	19.0
	4	60,950	44.0	54.0	20.82	18.6
	5	62,450	36.0	32.5	20.07	17.8
	6	62,200	36.0	29.5	20.07	18.4
Open-flame furnace.	7	74,850	31.0	29.0	24.50	20.8
	8	71,000	31.5	28.5	24.00	20.2
	9	66,800	42.0	45.0	22.55	19.8
	10	67,750	38.0	55.2	22.92	18.4
	11	68,050	45.0	54.5	22 92	18.4
	12	64,650	49.0	55.0	22.00	18.8

The conclusions arrived at were that repeated melting gradually lowers the ultimate strength, elastic limit, electrical conductivity and hardness of the metal. The ductility is not affected to any great extent, as shown by the elongation and reduction of area.

Opinion appears to be divided on the question of adding zinc at each remelting of the alloy to replace that lost by volatilisation. On the one hand, it is recommended, since with a reduction of zinc below the proper percentage the tensile strength falls, though ductility may rise; while other authorities, for somewhat indefinite reasons, proclaim the practice to be undesirable. Most makers of the standard alloys, however, recommend the addition of zinc after the first remelting; though even if this practice be accepted, careful regard must be paid to the amount actually lost, as that factor will vary considerably with different furnaces and different furnacemen. Moreover, it is, as a general rule, safer to allow a reduction of the zinc than to have an excess. Some decrease in physical properties is almost inevitable in remelting manganese brass, compared with the new alloy; and hence when really first-class results are required for a particular casting, it is best only to use new metals, leaving gates and risers from previous casts to be used up on less important work.

Without laying undue stress on the difficulty experienced in getting uniform results with different casts of this alloy, it must be admitted that slight differences in working conditions, as regards the rate of melting, the heat attained and the pouring temperature, will cause considerable variations in the strength of the castings. These factors appear to be more influential than small differences in the composition of the alloy. The trouble probably lies in oxidation, even though that is not readily observable to the experienced melter. One point to bear in mind is that where the highest tensile strength is desired, not only must oxidation be avoided, but also volatilisation of zinc. Less than about 54 per cent. of copper gives a hard and brittle alloy; but when the zinc is reduced below about 40 per cent. ductility is increased at the expense of the tensile strength. For high-tensile alloys, also, lead should be either absent or present in a minimum amount. Ordinary commercial zinc generally contains some lead and is, therefore, not suitable for high-class manganese brass: only the purest brands of zinc are allowable. The addition of iron is probably best done in the form of tinplate clippings, as this material is practically free from oxide, and is in the best form for ready melting in the alloy. The zinc may be added after the tinplate has been melted in the copper and well stirred.

Reference may here be made to the effect of additions of other metals. According to the experiments of one investigator, 0.5 per cent. of aluminium added to an alloy of Cu.52, Zn.46, Sn.1, and Fe.1, did not materially strengthen the alloy, though producing the characteristic manganese-brass appearance and rendering the metal more fluid. More than 1 per cent. of aluminium is not often added, about 0.5 being the usual amount. The addition of 3 per cent. of 50 per cent. ferro-silicon to the same alloy made it hard and stiff, with a slate-coloured fracture. Silicon, however, does not appear in usual manganese-brass specifications. No great strength was conferred by the addition of 3 per cent. of 10 per cent. phosphor-copper, though the structure was fibrous, the fibres ranging axially from the centre to the surface of the ingot. The effect of adding 0.25 per cent. of magnesium was to give the same alloy a white, steel-like fracture, making it hard but not tough. Manganese to the amount of 3 per cent., added as 16 per cent. manganese-copper, produced no change in the appearance of the fracture of the original ingot. The effect of adding manganese without iron to copper-zinc alloys is to increase the tensile strength and the elastic limit, while decreasing the elongation. The alloy becomes harder and more brittle, though the micro-structure is not materially altered, since the manganese enters into solution. The case is different, however, when iron also is added, the structure being quite distinct

The compositions of manganese brass used for casting may have a tensile strength from 32 to 38 tons per sq. in. with elastic limit varying from 15 to 19 tons per sq. in. and elongation from 15 to 30 per cent. on 2 in. Such alloys are largely used for propellor blades and similar work. Compared with the 60—40 brass alloy commonly used for castings, and with which can be got a tensile strength up to 25 tons per sq. in., with elongation of 45 to 50 per cent., the effect of the extra constituents of manganese brass is worthy of note. But perhaps a more correct comparison would be with a 55 Cu.-45 Zn. alloy, with which may be got up to 30 tons tensile strength with about 30 per cent. elongation. The latter is, of course, only obtained with first-class metals, and is frequently not reached in practice: but the possible results are not so far below those obtained with manganese brass of approximately the same copper and zinc contents. It must not be supposed, moreover, that the high figures given for manganese brass are representative of all the alloys that come under that heading, even though of standard composition. As before indicated, it is a simple matter, by wrong treatment in melting, mixing and casting, to get results far below those mentioned. It then becomes necessary to carefully maintain the proper conditions if manganese brass is to be usefully employed in place of the Cu-Zn alloy. The resistance to corrosion is, of course, a great feature in its favour where marine work is concerned, and this would appear to frequently be the deciding factor.

* Proceedings of the American Brass Founders' Association (American Institute of Metals).

Moulding for Manganese Brass.

Given a proper mixture of metals, it is still necessary to pay attention to the special requirements of the alloy in the matter of moulding. The agitation of manganese brass during pouring produces a frothy dross, which feature necessitates designing the runners so that the metal shall flow in as easily and quietly as possible. Bottom-pouring and a long runner are generally desirable in order to obtain clean castings. The long runner has the effect of collecting the dross and preventing it entering the mould, and whenever possible that style of runner should be employed. For many classes of work, contrary to the practice with most other alloys, it is preferable to gate the casting on a somewhat lighter part rather than on a heavy part; also, when the casting is fairly heavy a skimming gate is advisable to further assist in clearing the dross from the metal. Gating on a light part, of course, necessitates making other provision for feeding the heavier parts, and as the shrinkage in manganese brass is rather greater than in ordinary bronze, careful attention must be paid to the risers and sink-heads. When the design permits it, a riser should be placed to feed a heavy part, and this practice will go a long way to prevent shrinkage, cracking and similar troubles that would otherwise inevitably be experienced. The gates also, should be ample in size to allow a ready flow of metal into the mould, and these, too, will act as feeders during setting if they are properly designed and placed. A long drop in pouring the metal unduly churns it up, and is likely to cause dirt and dross in the castings; to avoid this a horn gate is necessary if the mould is a deep one.

Pouring.

In pouring manganese brass it is important not to have the metal too hot, though it is equally necessary to have a properly fluid metal. Too great a heat gives a coarse, crystalline structure, while too low a heat does not give a sound casting, and does not allow the development of the characteristic manganese-brass structure. The pouring should be continous and steady, contact with the atmosphere being avoided as far as possible so that oxidation and the consequent dirt and bad effects on the castings may be obviated. The correct pouring temperature is scarcely a matter for instruction, as practical experience and common-sense are the best guides; but as a general rule the undisturbed metal should not be so hot as to give off zinc fumes, though some fumes will be seen on moving the surface with a skimmer. With the foregoing facts in mind and a knowledge of the peculiarities of the alloy, it is not difficult to obtain sound casting with suitable metal.

Finally, it is of the utmost importance to remember that, quite apart from the pouring temperature, which has its own influence on the structure of the casting, overheating of the metal at any time during the process is fatal to good results. Metal that has once been overheated, either in making the ingot allov or in remelting, cannot be expected to give good results, no matter what the subsequent treatment may be, and no matter what care and judgment is exercised.

FREDK. BRABY & COMPANY, LIMITED, Eclipse Iron Works, Petershill Road, Glasgow.—This company are distributing to the trade a collection of booklets and pamphlets relating to their manufactures, these including their bi-monthly price-list and diary, and pamphlets on casements and sashes, rooflights, the "Corvus" window opener, rustless furnace pans, steel barrows, ash bins, tanks, corrugated roofing sheets, etc. We have also received a copy of Braby's Handbook for engineers and architects, a new edition of which has just been issued. In addition to particulars of the company's numerous sheetmetal products, this book contains a lot of useful data and engineering particulars.

Industrial Gas Furnaces.*

BY J. LORD.

There are many types of gas-fired furnaces, including the draught or Bunsen type, and the blast type. Also, in recent years, high-pressure gas furnaces and surface-combustion furnaces have come into vogue.

Draught-Type Furnaces.

This class of furnace is becoming more popular every year for uses in which low temperatures (up to 1,000 deg. C.) are required. This system has the advantage over the blast type that no power is required. It is not as economical in gas consumption and recuperation, but the furnace can be placed in any part of the works where a gas pipe can be run. The burners are of the Bunsen type, and are generally placed underneath the furnace, in different positions by different manufacturers. The success of a draught-type furnace is dependent entirely on the pressure of gas used. The writer has made a number of tests in this connection in a small standard furnace with a heating space of 962 sq. in., the object being to raise the furnace to 1,000 deg. C. with gas pressure varying from 10/10 to 25/10. With a gas pressure of 10/10, at the end of two hours we were unable to get a higher temperature than 800 deg. C. with a gas consumption for the two hours of 165 cub. ft., giving an hourly average consumption of 82.5 cub. ft. With a gas pressure of 15/10 we were able to reach 1,000 deg. C. in 90 minutes with a gas consumption of 150 cub. ft., and after reaching this temperature we were able to maintain the 1,000 deg. C. on 89 cub. ft. of gas per hour, thus showing that the empty furnace could be maintained at the 1,000 deg. C. with 33 per cent. less gas than it took to raise it to the temperature required.

Blast-Type Furnaces.

These furnaces are supplied with air under pressure varying from 1 to 3 lbs., according to the system. This type has two advantages over the draught system; it is about 10 per cent. more economical, due to greater pressure of the mixture of gas and air, and the recuperation is quicker after the furnace door has been opened. The writer has made tests with a furnace of identical type with the draught furnace mentioned, but fitted with blast burners. The object was to reach a temperature of 1,340 deg. C. With a gas pressure of 10/10 we reached this temperature in one hour; with a gas pressure of 25/10 we were only able to get 10 deg. more in the same time. In a recent lecture the writer stated that a blast-type furnace was more economical by at least 10 per cent. than a draught-type furnace. In tests recently made on various types of furnaces he has found even greater difference of economy, ranging up to 25 per cent. in favour of the blast-type furnace. With the small furnace, on which one of these tests was made, running the identical furnace with both blast and draught, the temperature arrived at was 1,200 deg. C. To attain this temperature with draught took 3¼ hours, with a gas consumption of 520 cub. ft. To raise the same temperature with blast took only 42 minutes, which is 500 per cent. quicker. The gas pressure in both cases was 25/10. Also, the heat could be maintained with 18 per cent. less gas when using blast as compared with draught. A test was made with the same furnaces to see what would be the drop in temperature by inserting a piece of steel, and what would be the recuperation. The weight of the steel was 20 lbs.,

* Abstract of Lecture before the West of Scotland Junior Gas Association, Glasgow.

the same being used in either case. The temperature of the draught furnace before the steel was inserted was 1,260 degs. C., the drop in the temperature after the steel had been placed in being to 1,050 deg. C., or 210 deg.; at the end of one hour the furnace had only recovered to 1,210 deg., and had the steel been allowed to stay until it had reached 1,260 deg. it would have been oxidised beyond use. The blast furnace also stood at 1,260 deg. C. before the steel was inserted, the temperature drop being to 1,110 deg. C., or 150 deg. C.; the time to bring this back to 1,210 deg. C. (equal to the draught furnaces) was 15 minutes, showing a considerable difference between the two types for recuperation. In the blast-type it took 56 cub. ft. of gas to recover to 1,210 deg. C., and in the draught-type 150 cub. ft.

In another test made on a furnace measuring 3 ft. by 2 ft. by 12 in., the temperature sought was 1,300 deg. C.; also a 1,000 deg. C. result was noted. With the draught furnace it took 90 minutes to reach 1,000 deg. C. with a consumption per hour of 500 cub. ft., and to maintain this furnace at 1,000 deg. C. took 280 cub. ft. In the blast furnace, to obtain the same temperature took 45 minutes (just 50 per cent. quicker), with the same consumption of gas for raising, but to maintain required only 240 cub. ft. of gas, showing practically 15 per cent. greater economy. In the 1,300 deg. C. test, the draught furnace took three hours to reach that temperature with a gas consumption of 1,500 cub. ft.; the blast furnace took one and a half hours to reach the same temperature with a gas consumption of 750 cub. ft—a 50 per cent. gain in time and 50 per cent. greater economy.

High-Pressure Gas Furnaces.

As regards this system, I maintain the assertion made in a previous lecture that judging from results obtained we can do better with gas under normal pressure using air under a pressure of 2 lbs. For high-pressure gas for furnace work, the gas must be supplied at a pressure of 10 to 12 lbs. per sq. in. In December, 1911, before the Manchester University, Mr. E. W. Smith quoted the following test in support of this system:—

Heat No. 1 melted 60 lbs. of brass in 1 hr. 14 mins. with a gas consumption of 218 cub. ft. the consumption of gas in cubic feet per lb. of metal melted was 3.633.

Heat No. 2 melted 59½ lbs. of brass in 1 hr. 35 mins. with a gas consumption of 236 cub. ft.—13 per cent. more gas than No. 1; the consumption of gas per lb. of metal melted was 3.933.

Heat No. 3 melted 63 lbs. of brass in 1 hr. 15 mins. with a gas consumption of 184 cub. ft.—6 per cent. less gas than No. 1; the gas consumption per lb. of metal melted was 2.9. This was his best result.

The possibilities are that he ran these three heats successively. If the average of the three heats be taken it will be found that it works out at 3.495 cub. ft. per lb. of metal melted. In a further test which Mr. Smith made during a three-days run with a 160-lb. pot, the average of gas consumed per lb. of metal melted was 4.146 cu. ft. These figures do not show that any gain has been made, but rather to the contrary; back as far as ten years ago it was possible with the "double-tangent" system, using gas under normal pressure with air under pressure of 2 lbs. per square inch, to melt brass with 2¾ cub. ft. per lb. of metal melted, and in a much less time. Taking the three heats using high-pressure gas, the average time to melt 60 lbs. of metal was 1 hr. 20 mins., as against 30 mins. ten years ago. To-day brass is being melted with 2½ cub. ft. of gas per lb. of metal, with a corresponding reduction in time.

Surface Combustion.

This system of heating by gas, due to Proefssor Bone and Mr. McCourt, has recently made rapid strides. Originally this system was operated with both gas and air, working under 1 lb. pressure; today successful results are being obtained with a pressure as low as 5 inches of water. Experiments are now being carried on with gas under normal pressure and air under a pressure of 1 lb. The temperatures obtained by the surface-combustion system have been as high as 2,000 deg. C. In one test with a surface-combustion furnace, with an internal working space of 5 ft. by 4 ft. by 2 ft., equivalent to 40 cub ft. of heating space, the work required to be done was annealing small malleable iron castings which were placed in boxes, each box when filled weighing 5 to 6 cwts. The total weight to be treated at one time was from 15 to 18 cwt. of metal. Producer gas was used, having a value in B.T.U. of 135 net. The furnace was first raised to 830 deg. C. before charging, and after charging the temperature dropped to 590 deg. C. For the first six hours the consumption of gas was 4,240 cub. ft. per hour, equal to 1,100 cub. ft. of town gas. By this time the temperature was brought up to 800 deg. C., and for the remaining 18 hours to maintain this temperature the furnace took 1,250 cub. ft. of gas per hour, or, equal in town gas to 300 cub. ft. per hour. Using the regular standard draught burner, the furnace would have required at least 1,350 cub. ft. of gas to reach the temperature and 700 cub. ft. to maintain it. This shows a saving in favour of the surface-combustion system of 20 per cent. in raising the temperature, and 50 per cent. in maintaining it.

Another test was made on a similar-size furnace, using producer gas with a B.T.U. value of not more than 130, the gas being poor. The object was to reach a temperature of 1,250 deg. C.—practically a forging temperature. This was obtained in five hours with a gas consumption of 6,500 cub. ft. per hour. The equivalent in town gas would have been about 1,100 cub. ft.

There is another furnace running at the present time with an internal working space 12 ft. long by 3 ft. wide and 15 in. high. The work required to be done is annealing brass rods, tubes and plates. The furnace is raised to 850 deg. C. in one and a half hours with a consumption of 1,100 cub. ft. per hour, town gas being used. To maintain the temperature of 859 deg. the gas consumption is 742 cub. ft. per hour, and in this hour from 12 to 15 cwts. of metal is annealed, the consumption thus being 56 cub. ft. of gas per cwt. annealed. With gas at 1s. 5d. per 1,000 cub. ft., this is equivalent to a cost of 1d. per cwt. of metal annealed. This system shows an advantage over the draught system of, roughly, 30 per cent.

Another furnace with an internal working space of 15 ft. by 12 in. by 6 in. is also showing remarkable results. A temperature of 1,500 deg. C. is reached with a gas consumption of 133 cub. ft. Operating the same with blast burners the furnace would take at least 300 cub. ft. of gas per hour to reach the temperature, and 300 cub. ft. to maintain it. With draught burners it would be impossible to attain this temperature.

Brass-Melting Furnaces.

Very rapid strides have not been made in this direction. The best that has been obtained up to the present has been 2.4 cub. ft. of gas per lb. of metal melted. There is one feature in this case which is worth considering, and that is the crucible after 30 heats was still in good condition.

Plaster of Paris in Foundry Work.*

By C. Heggie.

I intend to confine attention to plaster-of-Paris patterns and the uses of plaster-of-Paris (or stucco, as it is more commonly named in Scotland) in the pattern shop and foundry. In deciding the somewhat difficult question of what should be kept out and what included in this address, I have worked on the assumption that the subject is new to many of those present.

Plaster-of-Paris is obtained from gypsum, a mineral of a comparatively soft nature. The chief source of supply is the Tertiary strata of Montmartre, near Paris. Chemically gypsum is a hydrated sulphate of lime, $CaSO_4 2H_2O$, *i.e.*, it contains 21 per cent. water (or, say four-fifths sulphate of lime and one-fifth water). It usually contains, however, 10 per cent. carbonate of calcium also, not necessarily in intimate union with the sulphate, but interspersed in grains. The two processes by which plaster is obtained from gypsum are boiling and baking, the object being in both cases to drive off the water of hydration. In the boiling process this begins in about 1½ hours, and is completed in about three hours. The baking process is conducted in suitable kilns, and takes about 16 hours to drive off the water of hydration. This takes place at a temperature of about 250 deg. Fah.; the residue is then ground to the fine powder known as plaster-of-Paris. It was at one time thought that this was the anhydrous calcium sulphate, $CaSO_4$, but it is now recognised, chiefly from the researches of Le Chatelier, that it is the hemihydrate $2CaSO_4 H_2O$, and still contains from 7 per cent. to 8 per cent. of water. If, however, gypsum is burned at a higher temperature, say 480 deg. Fah., anhydrous calcium sulphate $CaSO_4$ will be obtained, but this does not possess the property of again combining with water, at least not in the same way as plaster-of-Paris. It is this valuable property of being able to recombine with water to form a soft paste that enables it to be run or strickled to the desired shape before it becomes hard and set.

Now, in reference to the setting; when the plaster (which is more soluble than either the hydrate gypsum $CaSO_4 2H_2O$, or the anhydrous salt, $CaSO_4$) is added to the water, it dissolves and forms a saturated solution. The solution, however, is supersaturated in respect to the hydrate and some of the dissolved salt separates out in this form, *i.e.*, $CaSO_4 2H_2O$. This sets free some of the dissolving water, which is then able to dissolve some more of the plaster. The process is repeated until all the hemihydrate becomes gypsum. After the mass is set it must, according to Rohland, be considered a solid solution of $CaSO_4$ in water, the particles of plaster being converted into a network of crystals mechanically enclosing the remainder of the water.

In commerce three qualities of plaster are sometimes stocked, classed as "superfine," "fine" and "coarse." In most shops, however, superfine will be found unnecessary, as some splendid work can be done with the fine material, and this can be improved when necessary by passing it through fine sieves. The coarse plaster is used to run up the pattern blocks or the heavier class of patterns when the thickness or section is suitable. Such patterns and blocks are usually finished with a coating of fine plaster. The quality of the powder can be tested by squeezing it in the hand, much in the same way as sand is often tested. Good plaster will cohere slightly when the hand is opened; otherwise it will fall to pieces, generally indicating injury by damp. It should be kept in a metal or wooden box with a suitable lid to protect it from dust and damp. The addition to the box of an inside hopper and sliding door is an improvement, as by this a minimum exposure is obtained.

The vessels used for mixing should be free from sharp corners, and with well-tapered sides if at all deep. A basin-shaped vessel with a handle and two small spouts for pouring is best of all, as this is easily cleaned, and has the advantage of exposing a large surface of water when the plaster is being added. It is scarcely necessary to say that the vessels should be kept clean, and fresh and clean water always used.

In mixing, the proportions of water and plaster have naturally a strong influence on the ultimate strength of the pattern; and while no hard-and-fast rule can be laid down (as each particular job must be considered on its own merits), in a general way a consistency of the mixture equal to that of a good cream will give best results. The *water* must first be placed in the vessel and the plaster then added. The latter should be sprinkled well over the water, giving it every chance to dissolve thoroughly. The addition of the powder should be continued in this manner until it is seen in a small pile above the water, it should then be quickly stirred, but excessive stirring weakens the mixture. No plaster or water should be added after mixing, as the plaster is thereby weakened, additional plaster evolves heat and causes swelling and warping of the pattern. A little experience and careful observation, however, will enable one to know when the correct quantity of plaster has been added.

I have made several experiments on the strength of plaster in relation to the proportions of water and plaster used in mixing, but, of course, their only value is as comparative tests. The method used was that of pushing over the sharp edge of an iron plate a section of plaster and finding the length of the part broken off by measuring the remaining piece. Two sections used were ¾ in. by 5/32 in. and 1 in. by ½ in. To decrease the length of the pieces broken off so that shorter test pieces could be used, a weight was suspended from one end, weighing in the first case ¼ lb., and in the second ½ lb. The following are the figures:—

Proportions of Water and Plaster by Weight.

Hours.	W. 6 Pl. 8	W. 8 Pl. 8	W. 8 Pl. 10	W. 8 · 11 Pl.	W. 8 Pl. 12
	Section ¾" × 53/32" (W. ¼ lb.)				
2	2 in.	3¼in.	4¼in.	5¼in.	5¼in.
26	3¼in.	6¼in.	7¼in.	4¼in.	9¼in.
	Section 1" × ¾" (W. ½ lb).				
2	3¼in.	5in.	7in.	7¼in.	8¼in.
2	—	—	—	—	*4¼in.
2	—	—	—	—	†6¼in.
26	3in.	4¼in.	6¼in.	7¼in.	8¼in.
26	—	—	—	—	*4¼in.
70	—	—	—	12in.	—
200	—	—	12in.	—	—
	With Lime.				
2	—	5¼in.	7¼in.	9¼in.	8¼in.
26	—	5¼in.	7¼in.	9¼in.	9¼in.
96	—	—	—	10¼in.	—
120	—	—	—	11in.	—
	Alum.				
2	—	4¼in.	5¼in.	—	8in.
26	—	3¼in.	5¼in.	—	6¼in.
200	—	—	—	—	9¼in.

*Carelessly mixed and overworked plaster. † Wrongly mixed plaster.

* Presidential Address delivered before the Birmingham Branch of the British Foundrymen's Association, October 25, 1913.

Attention may be drawn to the tests of plaster purposely mixed wrongly. The proportions are—water 8, plaster 12, which should give good results. The figures, however, are for two hours 4½ in., and for 26 hours 4¼ in., as against 8⅛ in. and 8⅛ in. respectively with correctly-mixed material. Further, all the test pieces, with varying proportions of water and plaster but all carefully mixed, were quite straight, whilst the pieces broken from the carelessly-mixed bar were warped and bent. Though these figures may be of no real value in themselves, they indicate that correct mixing and the proper proportions of the materials used are essential to a sound job. It is also essential with plaster work that the job be done quickly, and where possible with one mixing of plaster, as continual mixings and an excessive use of the template make the patterns weak and "rotten."

In large work where the mixture would be likely to set before completion, several materials can be used to retard setting. The following are given as accomplishing that object :—Lime, size water, ammonia and sulphate of zinc. The most common is, of course, lime water, which is mixed with the water before the addition of plaster, and is quite satisfactory. The lime should be slaked in a separate vessel and the lime water used, passing it through a fine sieve to prevent the larger particles of lime mixing with the plaster. It is also said that this hardens and strengthens the work, and it has been mentioned that its compressive resistance is increased by 40 lbs. per sq. in. from 120 lbs. with neat water to 160 lbs. per sq. in. with lime water. Alum water is also used to harden the work, but it quickens the setting. This, of course, is an advantage for certain classes of work, as for instance, where the plaster is simply poured into a mould. Like lime, the alum should be dissolved in water and the solution added to the neat water and stirred before adding the plaster.

In the general use of plaster, templates and strickles are essential, various methods being adopted in ordinary practice for the use of these. Fig. 1 shows a few of the more common. No. 1 is the ordinary strickle

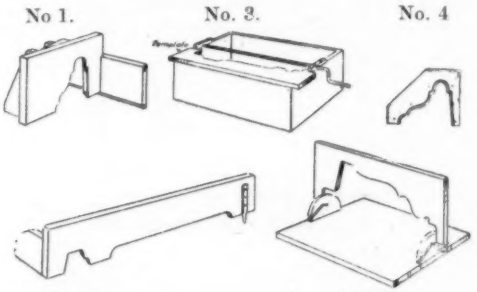


Fig. 1.—Strickles of Plaster Work.

for straight work; it is usually made to rest on the board and engage with edge of same. No. 2 is worked from a centre for true circular patterns. No. 3 shows the box for spindle work. It is used chiefly when iron shell patterns are required, but it will be readily seen that even for solid round patterns of an ornamental character it would in many cases give quicker and more accurate results than by turning the pattern in wood. Of course, when convenient, the turning lathe can be used for this class of plaster, the belt being pulled by hand. In No. 5 the strickle revolves on two centres and only a half-pattern is made by this means.

It is customary for fine and accurate work to use sheet zinc for the templates. Two pieces of zinc are cut to the necessary size, and the outside shape of pattern marked out on one of them and carefully filed to the drawing; the second piece of zinc, which is, of course, used for running the block forming the inside of pattern, is marked off from the first, less the thickness of metal required. Before this template is quite finished off, it is advisable to fasten the two together (a stitch with solder is customary) and punch screw holes for fastening to the strickle. The block template can then be finished accurately, as the thickness of metal can be measured from the face template. When the block has been run up, the template is removed and the face template replaced, the holes already mentioned ensuring the correct position. In work where the finish is not so important and when the template is not likely to be again required, the strickle is cut to the required shape, the thickness being cut out after the block has been run up, as is done in loam work in the foundry.

I propose discussing in detail a few typical cases of stucco work. Fig. 2 shows an ordinary 6-ft. gutter. The block is first run up as shown; it is then varnished, ordinary shellac varnish being used, and oiled.

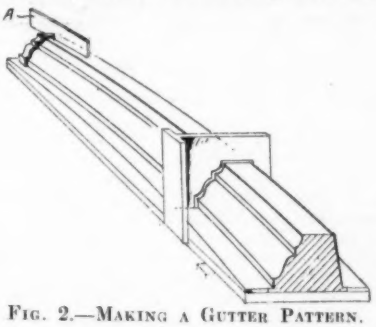


Fig. 2.—Making a Gutter Pattern.

The strickle is prepared to run the thickness of pattern, zinc templates as a rule being used for this class of work. With these gutters it is usually necessary to sweep or camber the plaster patterns to ensure a straight casting, owing to the irregularity in the cooling of the iron pattern and the castings from same. Instead of sweeping the board to the desired curve, it is ordinary practice to use a straight board and place strips of wood, termed risers, on this. These are planed to the required sweep, and the strickle takes its bearing on them, the edge engaging with edge of riser. For some patterns it may be thought necessary to give camber both ways. In such a case the edge of the riser would, of course, be shaped to suit. These risers can be easily altered or replaced to suit the necessary cambers for the varying sections of patterns. The faucet end of a gutter can be run up by small template, as shown at A, and afterwards finished by hand. In the case of a spigot end, the block is, of course, pared lower, instead of being made up, but otherwise treated as described. These gutters are made from $\frac{1}{10}$ of an in. thick, and for convenience in handling the plaster is usually cut longitudinally in two, these again being cut into 5 or 6 pieces.

Fig. 3 shows typical instances of circular patterns worked from a centre. No. 1 is a pig trough, about 3 ft. in diameter; No. 2 is a boiler base, from 3 ft. to 4 ft. in diameter; and No. 3 is a casting for a "Hotchkiss" boiler cleaner. To build up and turn a wood pattern and core-box for the latter would take a fair amount of time and material, while in plaster it is a comparatively simple job. I have seen it made both ways, the wood pattern being made in a shop where no plaster work whatever was done. Of course, the quantities of castings required warranted an iron

pattern being made, both halves of which were cast from the same plaster, as were both halves of the core-box, after the necessary alterations to core prints, etc., had been made.

In cases like these, where large blocks are required, it is usual to reduce the weight by packing up with material of lower density. Wood lagging may be used, but its tendency to swell and warp when in contact with the plaster makes it undesirable, and even where the wood is thoroughly soaked before using, there is still the risk of the block becoming warped when the wood dries. The most common practice is to use coke. Fig. 4 illustrates this. The following remarks apply in a general way to the patterns in Fig. 3. The coke is built up so that a suitable

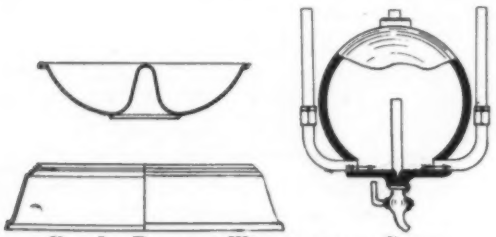


FIG. 3.—PATTERNS WORKED FROM A CENTRE.

thickness, say ¾ in., of plaster can be run on the top of it. A wood centre block is screwed to the board and carries the socket or plate in which the pin of the strickle revolves. The strickle in this case is made in two pieces, and jointed, simply for strength and to save material. There is a centre line on the plate so that it may be screwed accurately without trouble. No zinc template would be used for this, but the wood is bevelled well back, leaving the actual cutting edge about $\frac{1}{16}$ in. thick. The face and edge of template should now be varnished and oiled, as should also be the track of the template on the board. Besides assisting in a freer movement, this helps in the more ready removal of the superfluous plaster. After ascertaining that the position of the template will give the required diameter, the plaster is mixed and the block run up.

The thickness of the metal must now be cut from the template, the block touched up where necessary and varnished and oiled. I may mention here that very little oil is necessary; it is customary with beginners to use it to excess, with the result that it collects in angles and corners of mouldings, causing

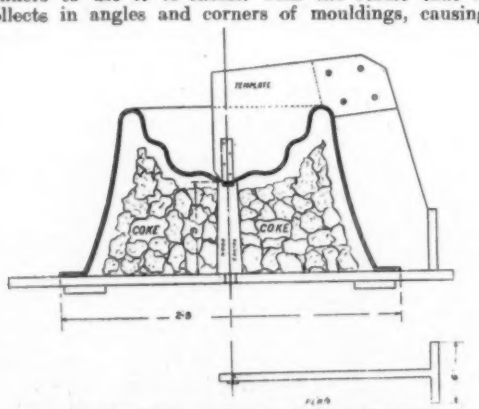


FIG. 4.—PACKING OF LARGE BLOCK PATTERNS.

them to be blunt and rounded when they should be sharp. The thickness should now be run on as smartly as possible. As before mentioned, the most satisfactory plaster work is that done quickly, and it should be noticed, while strickling, that no part is being missed, as this neglect may create the necessity for additional mixings of plaster and a prolonged use of the template over the whole job, adding to the expense and detracting from the quality of the work. All these patterns are cut into suitable pieces for handling by the moulder.

As regards the class of work usually done on the spindle or in the swing centres, in most of these cases a half-plaster pattern only is needed, iron patterns, of course, being made. Where core-boxes are required (many of these are used as shell patterns) they, too, are made from the same plaster. The two wood ends are firmly screwed to the board, and in them are holes in which the pins of the template revolve. The centres are, of course, sufficiently high to allow more than the half being made.

Figs. 5 to 7 illustrate one of the most useful branches of plaster-pattern making, *i.e.*, guide and track work. The time at disposal will not allow me to treat the

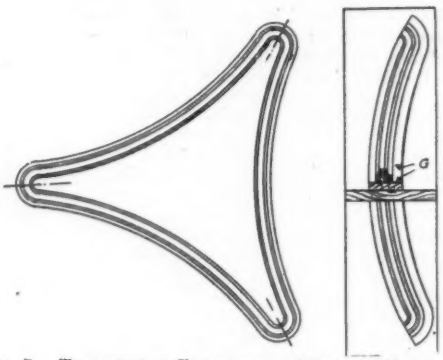


FIG. 5.—TRIANGULAR PLATE WITH MOULDED EDGE.

subject fully, but the possibilities of this section will be readily appreciated. The principle is to supply a guide or track for the template, and all sorts of irregular shaped work may be made in this manner.

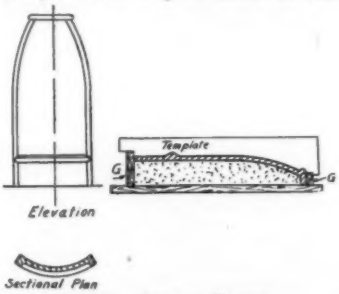


FIG. 6.—PILLAR GUARD.

Fig. 5 shows a triangular plate with a moulded edge The board is shown, and on it fixed the riser strip G, the edge of which acts as the guide for the template. Only one block was run up, and this was used to run the three sections on, which, when joined together, formed the complete pattern. The block afterwards was broken and the parts distributed to support the pattern. Fig. 6 shows a wall or pillar guard. The two wood ends shown at G are screwed to a board and act as bearers and guides for the template. When these ends are segments of a circle and concentric, some of the other methods already mentioned could be adopted, the chief usefulness of this method being in cases of irregular section.

Fig. 7 is the leg of a mantel register, and is made in much the same way. The guides G are cut to the shape shown in the end view, the template forming the ornamental section. With this class of work it is customary to make the finished patterns in some of the white-metal alloys, and as in many cases the designs are modelled in solid plaster, it is usual, instead of making a block and thickness, to obtain the thickness by embossing or "claying out" in the sand mould. Fig. 8 is another illustration of guide work. This shows the end of a cast-iron column for a pier; at the bottom is a flange or screw 3 ft. 6 in. diameter

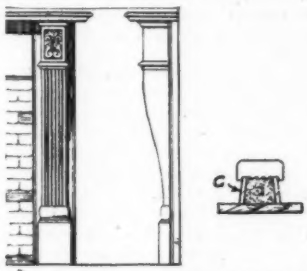


Fig. 7.—Leg of Mantel Register.

and 6-in. pitch. The column pattern itself was made of wood, but an iron pattern in two halves was made for the screw from the plaster. On the block, which is firmly screwed to board, is cut one pitch of the screw, and this acts as a guide down which the template travels as it revolves on the spindle.

The making of ovals can well come under this heading of "track work," although the method is slightly different from these previously mentioned. A simple oval frame, 3 ft. by 2 ft., as shown in Fig. 9, may be taken. For this a wood strickle and zinc template would probably be used, and the centre line marked off at half the length of the major axis, 18 in. A second centre line is then marked at half the length of the minor axis, 12 in. or 6 in. distant from first. Two centre plates are then screwed on at these positions. In the board, or in a plate screwed to the

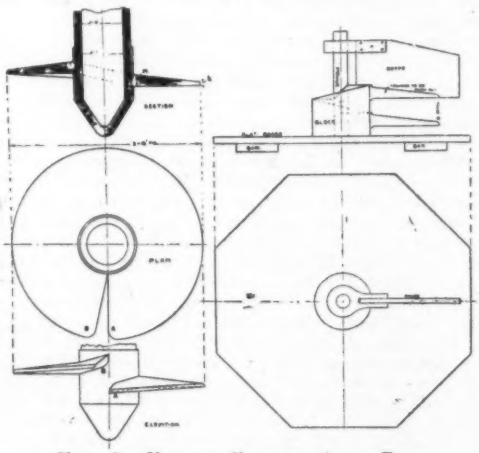


Fig. 8.—End of Column for a Pier.

board, two grooves are cut at right angles to each other, and of a size suitable to form a sliding fit with the centre pins, or with loose slides in which the pins fit. As the strickle is moved round, the centre pins travel along the slots, one in each, so that the template by the time a quarter of the oval has been run has travelled 6 in. nearer the true centre of the oval. The lines *a* show different positions of the strickle as it is moved round. An oval basin would be treated in much the same way. The slotted plate is carried by a wood centre screwed to the board. In large oval work the cross can be carried by a wood frame, built outside the track of the template. In such a case the template is suspended from the cross

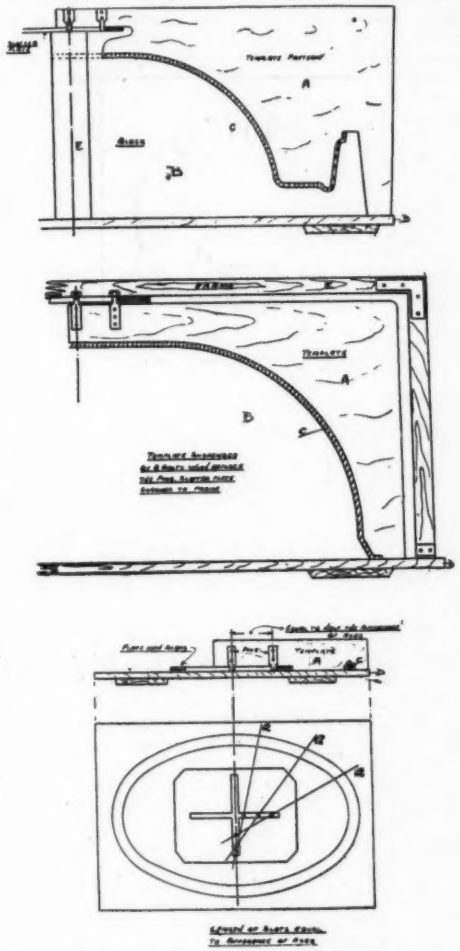


Fig. 9.—Making an Oval Frame.

by two bolts, which take the place of the usual pins in smaller work. In large work, round or oval, the templates are sometimes fitted with wheels to give an easier movement.

The patterns already discussed have been finished direct from the template, but naturally there are cases in which this cannot be done. Parts have to be pared to shape, additions made, curves altered by hand or by the use of further templates, etc. Two cases are shown, the first in Fig. 10. This is a fluted dome, the block of which is run up in the usual way, but it will be apparent that the flutes must be pared. The flutes on the block are carefully marked (the template being used for this as the lines are radial) and then hollowed out. This, of course, forms the back of the pattern. Before running the thickness, centre lines must be marked on the board to ensure the

flutes being marked and pared in the pattern exactly over those already made in the block.

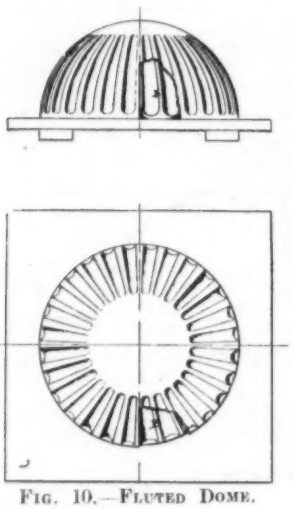


FIG. 10.—FLUTED DOME.

The 3-way pipe shown in Fig. 11 is another pattern that must be partly shaped by hand. The sockets might be run up on the spindle, or with the template swinging on centres, although in most places iron standard sockets would be used. The 12-in. and 7-in. diameter pieces would be run up on a straight board, as would also be the core-prints. On the top of the core-print an extra thickness should be run, this to be used later when altering the pattern to the core-box. The whole is then placed in position on the board, care being taken that the centre lines of the main pipe and branch pipes are correct, as both halves of the pattern are made from this.

The centre part of the block is now filled in with additional plaster and finished off to shape. The thickness to form the pattern is then poured on, small pieces of wood equal in thickness to the metal required having been previously placed on the block as a guide when this part is being pared. When the half patterns have been cast, the plaster is altered for the core-box. The pieces which were run on top of the prints are now placed in position, the prints themselves becoming the block for same. The outside of the pattern is then strengthened by strips, etc., snugs put on for pins and handles and the two halves of core-box cast from it. Of course in many cases of this class of work, shell patterns are made and no core-box used.

There are many ways in which plaster may be used with advantage other than in making complete patterns. On some work it may be found

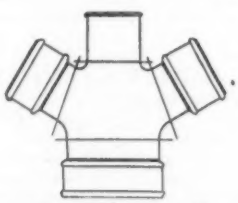


FIG. 11.—THREE-WAY PIPE.

that a large quantity of core-prints are required, or, perhaps, snugs, small ornaments, etc. By making two, or perhaps three, according to the size of the print or ornament wanted, and casting a plaster mould from them, it will be found that plaster casts of the required part may be quickly, and with assured accuracy, produced by the youngest boy in the shop. These prints may be nailed on, but it will be found quite satisfactory to fasten them in position with shellac varnish.

Perhaps the most useful of the many plaster jobs is the familiar odd-side, of which the brass and malleable founders take full advantage. The practice is carried a little further in some moulding machines where the joints are made accurately, so that the tops and drags are moulded on separate machines. Another instance where time is saved and of which the brass founder again takes full advantage, is in the making of core-boxes.

In many cases of ordinary round work, where the patterns are turned, what may be termed a wood core can also be turned and a plaster core-box taken from this, and even where the wood core cannot be finished in the lathe, it will often be found easier and more accurate to pare and alter by hand to the necessary shape and take a plaster box from it, than to joint up a wood core-box, mark, pare and gauge out to template. But, of course, it is not always possible or desirable to make these wood prints, and in some irregularly-designed patterns, where to pare a core-box in wood would take a considerable time to ensure anything like accuracy, another method is adapted. The pattern itself is bedded in the sand, and the joint made at the necessary places (of course, it may be found more convenient to place the pattern on a board and make joint up with wood or plaster). When the parting is made exactly as the core-box is intended to be, a wood frame is placed round and a plaster cast taken from the pattern. This joint is washed, trimmed up where necessary and slots cut in to form pins, and after being varnished and oiled, the pattern, too, being oiled, the second half of core-box is cast.

As we have now a core-box giving the same shape and size as the pattern it is necessary to fill in the thickness of metal required. Various materials are used for this, according to the shape and size of the pattern. Some of the white metal alloys which can be bought in rolled sheets of various thickness, will be found particularly useful, but plasticine, clay or wax, rolled or scraped between strips to the thickness, are often used. Those who try placing the white metal in awkward-shaped curves for the first time, may find it rather troublesome, but, with a little practice, it will be found that this method of making some core-boxes is both accurate and economical.

Again, in certain classes of work, the necessity arises of assembling some sets of patterns, having all the necessary holes, webs, brackets, etc., exactly as the castings would be. In making the castings many of these holes and brackets must be cored out, and it is found convenient and accurate to run plaster into these places on the pattern, and so form an exact core, with the addition where necessary of a core-print. These are then removed, a plaster core-box taken from them and replaced in the pattern. In many cases both prints and core-boxes are made in iron from the plaster.

In many patterns that are essentially made of wood, a part use of plaster often saves many hours' labour. Awkward curves, instead of being pared by hand to the template, can, in many cases, be swept to shape, and even where this is not possible it is quicker to fill in corners and recesses with soft plaster than with wood, and easier to finally finish off. The plaster has always one advantage over wood where paring has to be done; there is no "grain" to trouble about. Keeping this in mind it will sometimes be found more economical, both as regards labour and material, even when the whole job has to be pared, to cast a solid

block of plaster and finish from this than to make a wood pattern.

In many foundries a few castings are often required from a casting that has been sent in, the casting, I mean, being used as a pattern. In such cases holes and worn parts have often to be filled up, allowances put on for machining and contraction, broken teeth, webs, etc., made good, and it will be found that the use of plaster for such work will effect a considerable saving in time, especially so as some of the fractures are often very irregular, and it is so much easier to run plaster against the broken part than to fit wood. It is sometimes found necessary to duplicate patterns so that the output may be increased quickly for a short time. Where the pattern is suitable, a plaster mould can be made from it, and by casting the necessary pattern in this, the iron contraction trouble is overcome and the extra patterns similar in every way to the existing one may be in the foundry in a few hours.

Discussion.

Mr. H. Pemberton said that the lecture had demonstrated that there was much to be said for the use of plaster-of-Paris in pattern-making. He would like to ask what was the effect of damp and other atmospheric influences upon plaster patterns when they had to be stored for some time; also whether such patterns absorbed moisture, and if so, what was the best preventive.

Mr. C. B. Roe (Birmingham) said that he quite agreed with what had been said in the Paper with regard to alum. He personally had found it a very fine thing to add to plaster. Some experts claimed that French plaster was the best to use, he had gone through the works of various firms in Birmingham and found that only Italian fine plaster was used. As to Italian plaster, ostensibly two qualities could be got, called "Italian fine" and "Italian superfine"; but the so-called "superfine" was only the fine plaster put through a finer sieve. He did not think Mr. Heggie called attention to the fact that too much oil used was the cause of blow-holes in the casting. Having studied the uses of plaster-of-Paris very closely, he had often found that ordinary soap was one of the best things they could use for greasing the pattern. If the model were soaped and then allowed to dry, a clean casting could be got. There were various ways of dealing with the ornamental parts of the pattern. He had been connected with both iron foundries and brass foundries, and had seen how in many cases wasters had been produced through wrong methods of dealing with ornamental patterns. The best plan was to have the pattern made in wood, or metal, oil it a little, sink it into the sand about halfway, and then pour plaster over it. Having cut the plaster smooth on the face and given it a little time to set, the top half could then be taken off. There were various ways of getting the thickness of the metal. As Mr. Heggie had told them, it was just a matter of experience. One way was to make a mixture of beeswax, pea flour, and a little tallow, and having melted it down pour it into the mould, swirl it round and then pour it out, this process being followed until the desired strength was got. In that way it was possible to follow the outline of the pattern. Another way was to get ordinary pipe-clay, roll it on a piece of glass and place it in the hard mould. Having been cut into strips, it should be placed into the mould of the core-box, and pressed in with the fingers. Plaster-of-Paris should then be poured on the top of that. Then the clay should be taken out and wax poured in. By that means they would be sure of getting an equal thickness of the metal. It was a somewhat expensive way, but it was the surest, and was worth doing in order to ensure a safe casting. He had not used lime water, but alum water he had frequently used. With regard to the mixing, he had been in communication with the Italian masters, who used plaster-of-Paris in the work of the Schools of Art. Their method was to get a glazed basin, put the water in and then sprinkle the plaster all round the edges and let it sink to the bottom, and when there was enough plaster in to reach just above the surface, to get a spoon and beat up the mixture just as if one were beating up eggs. By that means they ensured the plaster being thoroughly mixed instead of breaking up into lumps, and very satisfactory results were obtained.

Mr. J. Shaw (Dudley) said that in his foundry, while plaster was used to a limited degree for making work as described by the author, great use was made of it to strike special forms of sockets on pipe patterns and special mouldings on column patterns. Having several large dies for stamping floor plates for bridges to make, the concave block was obtained quite true to shape by running plaster over the convex pattern. These dies weighed 7 tons each, the saving in pattern-shop labour was considerable, besides getting a true job.

Mr. R. Buchanan said that the method of running the oval which had been described and demonstrated, was new to him. He had, to a small degree, had experience with plaster-of-Paris, but he was afraid that the men with whom he was then in touch were fonder of running up shapes from metal of required thickness which had been rolled for them than of running with strickles. He remembered trying to get them to run strickle work, but it was not a success. With regard to the example of how a wrong method of mixing would cause the patterns to warp, he would say that he had had a considerable amount of experience with trouble of that kind. He thought that if he had to tackle a light foundry again he would be able to apply some of the hints he had received that evening, and would use the mixtures which Mr. Heggie had given them on the blackboard. These were in themselves most instructive. Hitherto, he had had only the haziest idea with regard to the proper proportions of plaster and water, and he was rather of opinion that the men he saw working at plaster patterns were pretty hazy about it, too; they usually tried to make sure of being on the right side with regard to the proportion of plaster by putting in plenty. With regard to the mantel register shown, he was not quite sure what relations the strickle would have to the sides of the leg where they differed in one part. He supposed the sides would be made with one strickle and the face with the other. He was referring to the depth, where it came out with pilasters on the top. No doubt the strickles would provide for the fluting, but he would like to know how that was done. He would also like Mr. Roe to give them the recipe for the mixture of beeswax, pea-flour and tallow. He remembered a man who made a vast number of patterns giving him a recipe, but it did not include pea-flour among the ingredients.

Mr. Sutton wished to know what could be done to prevent the plaster from swelling.

Mr. J. Bullock (Birmingham) said that evidently success depended a great deal upon the right plaster and the right mixing. They used to think that if they got a bucket and put plaster and water in and stirred it up, that was everything, but it was evident that a more scientific procedure was necessary.

Mr. D. Dalrymple (West Bromwich) said he would like to emphasise the advantage of plaster over wood

for making patterns. There were a considerable number of patterns now made in wood which he knew could be made much more economically in plaster; for instance, light circular domes, reflectors, and a great many other such articles. The use of plaster would save expenses in time and material. When a pattern was made in wood it was often found that when three or four were cast off, it became distorted and twisted out of shape altogether, and it took a considerable amount of repairs to keep it in working order; whereas if the patterns were run up in plaster it was only necessary to cast the first one in iron and dress it up as a permanent pattern, not only good, but also true. One could always get truer work in plaster than in wood.

Mr. H. L. Reason said that probably wood-pattern makers who were not accustomed to seeing plaster-of-Paris patterns made, would become a little alarmed; but there was no gainsaying the fact that if patterns of thin section were required up to a certain size, the same uniform and regular result could not be obtained from wood as from plaster. Brass patterns and iron core-boxes were invariably used in brass foundries where medium-size repetition work was made in large quantities. The pattern was first produced roughly in wood and then the brass or iron pattern made from it. From this, the core pin was made by same being reduced to give the required thickness of metal. It was surprising how accurate and uniform these could be made. The thicknesses of metal varied from 1/16th in. upwards. He was surprised to know the number of large patterns that were being made from plaster-of-Paris.

Mr. Roe, referring to the question as to the recipe for the beeswax mixture, asked for what purpose the questioner required it. For carving purposes the wax used was entirely different from the wax used for stocks. The wax for the stocks consisted of 8 ozs. of best beeswax, 4 ozs. of pea-flour, 3 ozs. of resin, and half of a tallow candle. The best way of putting in the resin was by melting the resin down and adding it in a melted state; it could be warmed up when wanted. He would like to add that they were trying what had been tried years ago, the adding of brick dust to the plaster-of-Paris. The way they had got the brick dust pure and fine was by floating it on the water. This addition caused the plaster to be longer in setting, and when the pattern had set it could be baked, and would set like a brick, and would last them for years. The recipe for the mixture was:—One-third plaster and two-thirds brick-dust, mixed with water. These moulds should be burned at a red heat, *but not those made entirely of plaster.* For smooth castings, the brick dust was separated into fine and coarse by throwing it into water. The coarse particles would fall to the bottom in a minute or two. The water was then poured off into another vessel, and the rest of the brick dust would gradually settle down as fine powder. This fine dust was mixed with fine plaster, and an even layer of it was carefully laid all over the model, which was then covered with the coarser mixture to the desired thickness. Of course, as Mr. Heggie had said, they had to suit their mixture to the work in hand.

Mr. J. Matthews (Walsall) said that, to his knowledge, plaster patterns had been kept for five and six years and were then as good as ever, and could be used at any time. (Mr. Roe: I have had some 20 years.) They must not make the core-sticks of plaster, but must make the patterns for the core-sticks as fine as possible, or they would find their core-sticks warp in casing—there would be a shrinkage, and the casting would not come out accurate and true. He would be glad if Mr. Heggie would tell them how to retard the expansion of plaster. Sometimes, in making, in handling two parts joined together by a lug the pieces would stick together owing to the expansion of the lug. This might be prevented by putting a little grease on the face. He had used for this purpose the lubricating material used on the foundry fan, and had found this serve better than oil.

Mr. Heggie, replying on the discussion, referred first to the Chairman's question as to the effect of damp on the patterns when stored. Undoubtedly, he said, if the patterns were left about in the sand they would absorb moisture, and therefore it was not desirable to keep them about any longer than could be helped. He was glad to hear Mr. Roe's remarks. As to the French plaster, he (Mr. Heggie) did not know whether or not French plaster was any better than what could be got in England. He believed that most of the plaster used came from Montmartre, but a great deal of good plaster was got in Cumberland, Derbyshire, and other parts of England. The Carlisle plaster was very good. It had a pink tint, but he did not think that made any difference to the quality. With reference to the mantel, the curve was got by the side-guides, which were made to the required shape of the two sides upon which the template was travelling. With regard to the swelling of plaster patterns, he believed that one way of reducing it was to mix the plaster properly. No doubt, badly-made plaster would swell, and warp, but if the proper proportions were observed and correctly mixed the swelling would be reduced, and he had no doubt that the addition of lime would further reduce it; but he had not made sufficient experiments in that direction to give figures.

Materials for Turbine Parts.

Data regarding materials used in superheated-steam and gas turbine construction for parts exposed to the action of hot gases and at the same time to high stresses show that notwithstanding its high melting point, pure nickel cannot be used on account of its fragility at high temperatures. Wrought iron appears to be very suitable for superheated-steam turbines. The tensile strength of 932 deg. Fahr. falls from 52,600 lbs. per sq. in. to 18,400 lbs. per sq. in., but according to Rudeloff at 400 deg. Cent. (752 deg. Fahr.) it still has a tensile strength of 45,500 lbs. per sq. in. and an elongation of 40 per cent. It is used for blades in the Thyssen and Melms & Pfenninger steam turbines. Ordinary bronzes have not proved satisfactory, but some of the special bronzes gave good results. As regards special alloy steels, the tests of Fabry, at the laboratory of the Hungarian Roval Iron and Steel Works, have shown that at high temperature low-carbon steel is superior to high-carbon steel. Rudeloff has found that nickel steels with 8 to 16 per cent. nickel materially increase in strength when slowly cooled after heating. Carbon-free nickel-iron alloys patented for use in turbine blades by the Brown-Boveri Company have failed in laboratory tests. Regular 5 per cent. nickel steel has proved to be very efficient, while higher nickel steels (25 per cent.) have not been found to be quite as good. On the other hand, Guillet, on the basis of extensive tests, recommends for blades steel of 30 to 32 per cent. Ni and maximum 0.12 per cent. C. This steel has the further advantages that its coefficient of expansion is small, and that it does not rust in clean water. As regards Monel metal, there is little doubt as to its good qualities, especially in the composition 69 per cent. Ni. 27 per cent. Cu, and the rest iron and manganese, but it is so hard that it cannot be conveniently rolled; at least, that has been the experience of the Heckmann firm in Germany, which finally discontinued its manufacture. This firm makes, however, turbine blades of a softer material, with 65 per cent. Ni content.

Cast Iron: Its Nature and Properties.

Before the Birmingham Branch of the British Foundrymen's Association, on November 22, Mr. C. Heggie (President of the Branch) in the chair, Mr. F. J. Cook gave an illustrated lecture on "Cast Iron; Its Nature and Properties."

Cast iron, the lecturer said, consisted of 89 to 94 per cent. of iron, together with certain materials usually spoken of as impurities, such as phosphorus, silicon, manganese, and sulphur. There were also mixed with it traces of other elements such as nickel, copper, vanadium, titanium, etc., but for commercial purposes those elements were never taken into account. The elements varied in different proportions according to the place from where the pig-iron was obtained. The proportion of total carbon varied from 3 to 4 per cent., and the proportions of combined and graphitic carbon would depend upon the amount of other elements present. The silicon might range from 0.5 per cent. to over 4 per cent., though where it exceeded 4 per cent. it was looked upon as something in the nature of an accident and the iron in that case was known as glazed pig. Sulphur varied from 0.04 per cent. to 0.2 per cent.; phosphorus from a trace to 2 per cent., and manganese from a trace to 2 per cent., so that there was by difference iron 89 to 94 per cent.

Probably most of them knew that wrought iron was obtained by putting iron such as he had described into a furnace and burning off by different methods the whole of the impurities and leaving the pure iron behind them. In fact, all that was done in making wrought iron was to get rid of the elements other than iron. They were also, no doubt, familiar with the general properties of wrought iron; it was malleable, and could be forged, welded, and was so soft that it could be tied in a knot.

The addition of the elements previously mentioned, however, had a wide effect on the different physical properties of iron. By adding these elements, even in less proportions than those named, an iron was got that could not be welded, twisted, forged or dealt with in any such way as wrought iron could be. If small quantities of sand were mixed with sugar it would not alter the physical properties of the sugar. In the same way, if the elements named were simply mixed with the wrought iron the quality of the iron would be reduced, but it would still be wrought iron. The change which these elements made in the iron was due to the fact that they did not form a merely mechanical mixture, but went into combination with the iron and formed chemical compounds. If a piece of wrought iron were put into a metal box and surrounded with plenty of carbon in the shape of charcoal and then put into a furnace for a certain length of time, the result would be that the material when it came out would no longer be wrought iron. It would have all the properties of what was known as tool steel. (That was not the way tool steel was made to-day, but it used to be made that way, by what was known as the cementation process.) The metal after undergoing that process had lost the physical properties of wrought iron; it could not be welded, it was very difficult to forge, and it would not bend in the same way as wrought iron would; it was very hard and would cut other metals. In some iron when it was molten one atom of carbon would combine with fourteen times its weight of iron. The compound of iron and carbon was very different from either iron or carbon. It was very hard and brittle, and the combination had the effect of considerably reducing the temperature at which the iron became molten. Carbon could form two compounds with iron, one Fe_3C and the other $Fe_{14}C$.

The lecturer then exhibited upon the screen micrographs showing the effects of different combinations upon the structure of iron, and explained that phosphorus formed at least two well-known compounds and could occupy from 3 to 6 per cent. of the mass. The effect of these compounds was to make a very vast difference in the qualities as compared with wrought iron, the result being that the metal could be cast easily at a reasonable temperature and be melted in the cupola and in all sorts of ways. Although these elements were spoken of as impurities they were the vital elements to the founder, because without them cast iron could not be obtained.

Carbides of iron, or combined iron and carbon, took up 12 to 14 per cent. of the mass, silicon from 7 to 7.5 per cent., and sulphur, 10 per cent. There were, of course, other compounds besides these, and the impurities also formed compounds among themselves; for instance, manganese and sulphur formed manganese sulphide. The whole of these compounds could be quite easily detected in the metal by observing them under the microscope, and many of them had been separated from the iron and their composition ascertained. Some examples of the appearance of the different compounds under the microscope were then given on the screen. In cast iron, the lecturer said, there was practically never any free iron, *i.e.*, iron similar to wrought iron; practically, whenever much combined carbon was present there was no free ferrite. In cast iron when molten the carbon was in the combined state, and if the iron at this stage was dropped into ice-cold water and then broken it would be found to be white iron. This white iron was often found on the fins of castings, owing to the quick cooling causing the carbon to be retained in the combined form. In castings, as the metal cooled down from the liquid state, the carbon which was in the combined form began to come out and to take the form of graphite. The size of the graphite was dependent on the fluidity of the metal, the carbon as it came out of the combined form tending to aggregate by what was known as molecular attraction. There was a stage between the combined carbon and the graphite that was very useful in iron castings, and that was known as the pearlitic stage. In all cast irons pearlite was associated with the highest strengths. Having explained the meaning of eutectic, the lecturer showed a slide in which the phosphide eutectic was pointed out.

He had shown that the most important element in connection with cast iron was carbon and that the value of the other elements present were in accordance with the effect they had upon the carbon. Silicon in itself had the tendency to make iron harder; yet it acted as a softener by the mere fact that it increased the time taken in cooling. The longer the metal was in cooling down, the larger were the plates of graphite and the softer would be the iron. Sulphur and manganese had quite the opposite effect, having the tendency to reduce the fluidity of the iron and cause it to cool more quickly. Anyone who had to deal with hard iron in the foundry knew that the harder the iron the more quickly it became dead. Malleable iron, for instance, was very difficult to melt in the cupola, and when it was melted it had to be dealt with

quickly or it would go dead before pouring was finished.

It might be definitely said that the physical properties of cast iron were governed by the quantity and the condition of the carbon present. In England one very seldom heard of the question of quantity of carbon in iron, whilst people spoke quite glibly of the amount of combined carbon that was present. The total quantity of carbon present had a very great effect on the quality of the metal. It was necessary—if the best results were to be obtained—to get a proper equilibrium or solution point in connection with carbon and silicon. If they got this point perfectly fixed they might leave the question of combined carbon to take care of itself, provided they took care not to have an abnormal amount of sulphur or manganese present. A formula which gave the proper balance between the silicon and carbon, or the saturation point for the carbon, was as follows :—

$$Sc. = \frac{C}{4.26 - \frac{Sil.}{3.6}}$$

Where C. = total carbon, Sil. = silicon in the iron, and Sc. = saturation point of carbon.

For pans, grates, easily-machined castings and pipes etc., Sc. should equal 0.9 to 1.0.

For loco. cylinders, Sc. should equal 0.85.

For steam, gas, and hydraulic cylinders, Sc. should equal 0.76 to 0.8.

For chilled castings, Sc. should equal 0.75 to 0.88.

Just to see how the formula worked out, he would take a case in point. There were plenty of steam cylinders made to-day with no better analysis than 2 per cent. silicon and 3.5 per cent. total carbon. He did not say that that was a very bad mixture, for it would serve well enough where the steam was not highly superheated. Working out the formula for this mixture, Mr. Cook showed that the result would be above the figure given for that class of castings in the list above.

Dealing with the rate of cooling upon the composition of cast iron, Mr. Cook exhibited a photo of a bar cast in the shape of a wedge and then of sections of the bar taken at various points, showing that while the thin end consisted of hard white iron, the composition gradually altered until the thick end of the iron was wholly soft. This, he said, was due to the fact that the rate of cooling became slower as the casting became thicker. The relation of the rate of cooling to the physical properties of the metal was illustrated by tables of tests made upon a series of test bars, all made from the same iron and all cast in the same mould. Other illustrations of the results of different rates of cooling with various mixtures showed the enormous influence of the rate of cooling upon the physical properties, and the importance of getting a class of metal that would cool at the right rate if it was desired to get a strong casting. With the aid of further micrographs the lecturer showed how the distribution and form of the graphite in the mass was related to the rate of cooling.

In addition to the rate of cooling, Mr. Cook continued, it had often been found that irons of exactly the same chemical analysis, after being treated as far as one could tell in exactly the same way, had very different breaking strengths. He had a very peculiar example of that some years ago, and it was made the subject of a research by Mr. Hailstone and himself. Generally speaking, bars made from metal of the same analysis and under the same conditions exhibited similar properties under test, but he was very much surprised to find that in this case the tensile strength varied considerably. He was not speaking of an isolated bar, but of bars cast over long periods. The series represented sixty days' work on consecutive tests. All that time he had come across a fresh brand of iron which was very much cheaper than what he had been using, but which had the same chemical analysis and appeared to be for all practical purposes identical with the other.

There was nothing in the chemical analyses or micrographs prepared under the usual conditions to indicate the wide differences in the physical properties, but they took the formula of Dr. Stead for isolating the cementite and phosphorus, *i.e.*, to etch very deeply with nitric acid, and the results were that they got micrographs showing that the cementite and the phosphorus took no definite form in weak irons, but took up a net-like structure in strong irons.

Discussion.

The PRESIDENT said they had had a very interesting lecture, but Mr. Cook might have gone a step further and told them how to get the fine graphite and the network structure of which he had spoken.

MR. R. BUCHANAN said that Mr. Cook had referred to the crystals of iron as being probably not pure iron. That was a question which he, Mr. Buchanan, had raised with a noted metallurgist, who, however, had no definite knowledge about it, though he did not think that the crystals were pure. He had an opportunity of submitting questions to Dr. Tutton, a Fellow of the Royal Society, who was a noted crystallographer, and who gave him to understand that the crystals of ferrite found in cast iron were not pure iron, but possibly had manganese or some other elements dissolved in them, though only to a very slight amount. When Mr. Cook came to speak about chills being used on the test bars it should be explained that he meant the body used to densify the metal and not the chilled bar. They badly wanted some term by which they could define the thing that caused the chill and differentiate it from the thing caused. They called the body which was used to cause the chill, a "chill," and they gave the same name to the effect. He hoped that someone would give them a good term by which to name the *effect* caused by using an exterior chill. When engineers were spoken to about a chill they always thought that white iron was being referred to. He would submit a term which he thought might be used for the exterior chill, and that was "densifier." He thought it was in the line of work which Mr. Cook had been following to speak of "densifying" his test bars, and if they used that word they would avoid a difficulty to which he had referred.

MR. BROUGHALL (Alfred Herbert, Limited, Coventry) remarked that with regard to the use of chills, it struck him when Mr. Cook was illustrating his researches on the effect of rate of cooling, and showed such a difference in fracture at the top thin portion of a wedge to that at the lower thick portion, what a hopeless task it was for foundrymen to attempt to make sound castings which varied considerably in thickness. In their foundry they struck this apparently hopeless task some time ago, but he thought they had now got over it very successfully. They used hundreds and perhaps thousands of chills; in fact, there were very few of the castings they made without a chill being used on some parts. They could not possibly produce the sound castings they were called upon to produce except by this means. Probably a few of those present had seen in the Edgwick Foundries certain bars of cast iron which were cast in iron moulds. Although it might be doubted, it was a fact that bars cast in these iron moulds machined much easier

than bars cast in a sand mould. These bars could be machined at a cutting speed of 300 ft. per minute. In such things as large cone pulleys at the point where the plate part matched up to the cone part, it was almost impossible to get this junction absolutely close without the use of a chill, but when a chill was introduced this could be done quite successfully. Some of them were probably acquainted with the hexagon turret which formed part of the Herbert No. 4 capstan lathe; this casting was about 9 in. across the flat and about 6 in. deep, and was cast solid. Years ago they had endless trouble in getting these castings sound when cast in sand moulds, but it had been the practice for some years now to make the castings in an iron mould, which made them absolutely sound. Since this practice had been adopted they had cast hundreds of these turrets, and had never had a bad one. By the use of chills it had proved quite a simple thing to get over a great many of the troubles the foundry had through drawn castings and porous patches. There was no difficulty in making these chills; in fact, they were made by the moulders themselves, a pattern being made to fit round the part where the cooling required accelerating, and from this pattern the chills were cast, the thickness of the chill being adapted to the size of the casting and the rate of the cooling desired. With regard to Mr. Buchanan's suggestion as to a name for the densifiers, it was, of course, wrong to call these articles chills, but one had to take into consideration the fact that foundrymen were well used to this word and knew exactly what it meant. He was afraid that if they went to some moulders and told them to put a densifier on a certain pattern, they would not know what was meant. He had been delighted with the experiments Mr. Cook had carried out, as they exactly confirmed their experience with densifiers at Edgwick Foundry.

Mr. F. Harvey (West Bromwich) said that one point in Mr. Cook's very valuable lecture that had interested him, and was especially valuable and interesting to chemists, was the formula for carbon and silicon. But that formula, taken as it stood, was very liable to be misunderstood, and he would just like to be reassured as to whether it was to be interpreted irrespective of other constituent elements. Another point which the Paper emphasised was the fact that chemical analysis alone told them very little with regard to the physical properties of cast iron. It also emphasised the fact that microscopic work was a very valuable aid to chemical analysis.

Mr. H. Pemberton (Midland Railway Works, Derby) said that it would have been very interesting if some information had been given about the transverse test in relation to microstructure. He would also like to know how to get the network formation which had been described. What Mr. Cook had shown them was somewhat damping to chemical analysis in foundry work, because he had shown them that two irons of the same analysis did not give the same physical properties, and that the strength was due to the network structure, as to which he quite agreed with Mr. Cook. He would like to ask, with regard to the bars shown, if Mr. Cook could state what area the pearlite should occupy in the mass of, say, a casting of sixteen tons tensile strength.

Mr. J. J. Howell (Smethwick), in reference to the formula that Mr. Cook had given, said that it seemed to him that the formula as given, was too closely related to the question of silicon control. Nowadays they did not believe absolutely in silicon control, but considered that the other elements somewhat determined the action of the silicon. Mr. Cook said that the amount of carbon present and the condition of that carbon determined the suitability, or otherwise, of a casting for a specific job. With that he entirely agreed; but silicon was not the only element to be considered when making up a mixture for any particular class of work. Manganese, sulphur and phosphorus had a part to play, and must be considered. For instance, if one had an iron with the analyses, C, 3.5; Si, 1.5; S, 0.06; Mn, 2; it was obvious that the manganese demanded attention, for the sulphur content was not high enough for the formation of manganese sulphide; therefore the whole, or nearly all, of the manganese would be present to exert its known influence on the stability of the carbon. Perhaps Mr. Cook would give further information on that point taken in conjunction with the formula he had given.

Mr. Broughall remarked that as Mr. Cook had rather given away chemical analyses, he would like to point out that for seven years they had run their foundry absolutely on Keep's test, without taking any chemical analyses of the mixtures, except on rare occasions as a check to the Keep's test. Of course, it should be understood that every consignment of pig-iron was analysed before being used, and this analysis used as a guide in making up the mixture. Under these conditions it was, of course, most necessary that test bars be taken every day from each mixture used.

Mr. F. J. Cook, in his reply, referred to Mr. Heggie's question as to how to obtain the network structure. That depended, he might almost say, upon scientific work in the foundry. If they wished to have uniform success in high-class foundry work they had to watch very carefully all the elements of the problem, all the things which were essential, if they were to be doing the same work with the same success every day. They had to analyse the raw material. (He quite agreed with what Mr. Broughall had said regarding the value of Keep's test; they used it every day. They took analysis for each of the kinds of pig-iron used, but the mixture itself they largely judged by the result of Keep's test.) Then great attention had to be paid to the method of blowing in the cupola, to both the volume and the pressure of the air. By following this up they would soon get experience which would enable them to turn out practically the same work day after day. Even then one might sometimes get an iron that gave different results in spite of the fact that the chemical analysis showed no difference, and the only thing to do in that case was to drop that iron for no other reason than that it would not do what the other irons of similar analysis would do. There were foundries where they did not have these tests, and where there was no air gauge and no recorder, but if they wished to repeat any result regularly they must watch carefully all these points. If they did so they would have no difficulty in getting that network structure. The question had been raised by Mr. Buchanan of whether the crystals in cast iron were pure. He (Mr. Cook) thought it was generally considered, although no work had definitely proved this, that the crystals were not absolutely pure iron. If they had iron mixed up with all these other elements, he thought it was bound to be contaminated to some extent, but to what extent was not generally known. The bogey of the meaning of the word chill had come up again in that discussion. Densifier was a very neat term, but he thought foundrymen generally understood that a chill was something that was to cool quickly. With regard to the value of the chill he could bear out what Mr. Broughall said. In their foundry they used hundreds of chills every day; every cylinder, every piston was cast with chills. It was the only

way to get over the difficulty due to having thick and thin parts in the castings. Unfortunately, in England engineers' draughtsmen generally knew practically nothing about crystallisation, and the only way to avoid trouble from their mistakes was by the use of chills. Mr. Broughall also spoke about chill castings being easily machined. That was the case. He (Mr. Cook) had tried to point out that in a chilled casting there was no extra formation of cementite. The iron was cooled more quickly and the result was that the graphite was much smaller, but there was the same amount, and the iron was as soft as when the graphite was larger. Mr. Broughall had also pointed out that it was very necessary to insure that the chill was not moist and he (Mr. Cook) quite agreed with that. It was also important to take care that there was no rust on the chill because there was a certain amount of moisture in the rust, so that when the hot metal came against it, gas was given off and might cause blow-holes. Like Mr. Broughall, they did not use a coating of any description on the chill. With reference to the formula he had given, the object of it was to give the equilibrium between silicon and carbon. To have a strong cast iron this equilibrium was essential. With regard to the question of silicon control, raised by Mr. Howell, in America everything was judged by silicon control only, but silicon must be taken into account in connection with carbon because that was the element that was generally in the largest proportion in cast iron and the equilibrium between silicon and carbon was essential. With iron of normal composition there was no need to trouble about combined carbon if they got the equilibrium between the carbon and the silicon correct, but they must be very careful not to get abnormal sulphur and manganese. If they got the equilibrium between the carbon and the silicon, they knew where they were to start with, and had then only to watch the sulphur and manganese. The latter were two easily-controlled elements. A good many people cried out about sulphur, but that was easily dealt with. Phosphorus was generally accepted as having no effect whatever on the condition of the carbon, neither throwing it into the combined form or otherwise. He thought that was very clearly proved by Dr. Stead and others.

The PRESIDENT: Is there any effect on the total carbon?

MR. COOK replied that the addition of other elements generally had the effect of lowering total carbon. But the chief effect of phosphorus, especially with hard iron, was the reduction of shrinkage. With regard to chemical analysis, he thought everyone who had had to do with the scientific investigation of cast iron would agree that chemical analysis was a very useful aid in making a mixture, but there were also one or two other matters which had to be taken into consideration. Referring to Mr. Pemberton's remark about his admission of the possibility of making mistakes in laboratory work, Mr. Cook said that he was sure most experimeters would agree with him that it was almost impossible to get absolutely uniform results, largely owing to the difficulty in getting absolutely uniform samples. They might give the same metal to different people, who were all equally skilful and without apparent weakness in their methods they might all get slightly different results. Mr. Pemberton raised the point of transverse tests, but he might say that in every case given on the screen transverse tests had been given. He did not take great pains to point them out because many people objected to transverse tests; they also took Keep's tests every day, and these were all given in the table. With regard to the areas of pearlite, Mr. Hailstone and himself had never taken that point into account, nor did they think it necessary. They felt, after thousands of tests, that what mattered most was the size and configuration of the network structure. If they got that right there would be quite sufficient pearlite to maintain the strength.

A hearty vote of thanks was given to Mr. Cook for his lecture.

British Foundrymen's Association.

Annual Dinner of London Branch.

On Saturday, December 13, the London Branch of the British Foundrymen's Association held their annual dinner at Holborn Restaurant, London W.C. Mr. J. Ellis, Branch-President, occupied the chair, and a large number of members and visitors were present.

After the loyal toast had been duly honoured,

MR. R. WOODS (Branch Vice-President) proposed the toast of "The Visitors," expressing the welcome which the Branch extended to visitors at the meetings as well as to the social functions. He referred to the useful educational work of the Association and coupled the toast with the name of Dr. R. Mullineux Walmsley, Principal of the Northampton Polytechnic Institute, in whose buildings the Branch meetings were held.

DR. WALMSLEY, in responding, said that association of the Northampton Institute with such a body as the Foundrymen's Association was highly desirable, and the Governors of the Institute greatly desired that the Branch should continue to hold its meetings at the Institute. He referred to the fact that most of the other Branches of the Association had found accommodation in the technical schools and institutes, and he regarded those places as the real homes of the Association. Continuing, he remarked that the knowledge and the lack of knowledge on metallurgical matters together was very great, but the balance was very unevenly divided. There was still much to learn compared with the little that was known. Also, there was much already known by the practical man which was not known by the scientist, and which never got into print.

M. P. DELELANDE (a member of the French Foundrymen's Association) proposed the toast of "The British Foundrymen's Association." He referred to the progress made by the French Association, which had only started in 1910, and had added over 100 extra members since the Paris Convention in May last. He greatly appreciated the work of the British Foundrymen's Association, and wished it a striking continuation of its past progress.

THE CHAIRMAN, in briefly responding, mentioned some of the work, apart from the meetings, upon which the Association was engaged, including the work of the Committee on Apprentice Training, whose reports in due course would be very helpful and valuable. He also mentioned the scheme for prizes which had been inaugurated.

MR. T. MURPHY (the Branch Hon. Secretary), in proposing the health of the Chairman, drew attention to the fact that the London Branch was the second strongest in members of any in the Association, and was probably the strongest from a financial standpoint, owing to the large proportion of full members compared with associates.

Openings for Foundry Progress.

At the opening meeting of the Newcastle-on-Tyne Branch of the British Foundrymen's Association, Mr. R. Wallis, President for the second year, in the course of his presidential address, reviewed the lines on which foundry progress had been made in the past, and also endeavoured to indicate directions in which further advancement was possible.

Briefly reviewing some of the more important developments, and the lines along which these developments had proceeded, he said that the metallurgist and the chemist had developed the blast furnace and its control until it could turn out a casting of any desired size or quality. This statement might be questioned, but if the demand for a certain article was sufficient he had no doubt that the metallurgist could give them what was required. The chemist had also determined the effect of impurities in the metal, and the actions of metals on each other much more accurately than before, again enabling the founder to produce castings having the desired properties for the purposes required. The properties of the various metals had received some attention, and just as the metallurgists and the chemists had rendered valuable aid in the progress of the moulders' art, the mechanic had also advanced the mechanical appliances, and the appliances now at the hand of the founder were much more varied and more applicable to the work than they were twenty or thirty years ago. The mixing of sand was now a mechanical operation. Cranes, which in the old days were to a great extent worked by hand, had gone through various stages, and now prominent features were electric, hydraulic and pneumatic devices for overhead cranes. Moulding machines now enabled duplicate work to be turned out at a smaller cost and with accuracy which was before altogether unknown. Core-making was now also to a certain extent the work of a machine. The moulder had learnt his limitations in certain directions, and whether it was desired to make a casting in loam, dry sand, or green sand, he could, if necessary, take precautions to turn out a casting true to the pattern. The moulder had been taught in the school of experience to avoid strains, draws, and pinholes as far as his skill and ability could avoid them. Practical experience, together with the research work of the chemist, the metallurgist and the mechanic, had within recent years advanced the foundry industry to a stage of which their forefathers scarcely dreamt.

Few districts produced sand suitable for all classes of work, and thus sand had to be imported from other parts of the country, and he thought the composition of sands might be investigated by the chemist, and the man who could adopt local sands and treat them in such a way as to be suitable for all classes of work would have achieved something. The various available sands varied in their character, and were suitable for certain classes of work, but it was quite possible that an ordinary sharp grit sand could be treated in such a way as to replace loam. This would mean a cheaper material, and likewise an economy in the production of castings. Another matter which might be investigated with good results was blacking and its uses. At the present time a great many founders were using a blacking composed chiefly of charcoal, and depending upon the volition of the gases in the burning of the charcoal to put a skin on the castings. This caused the casting to strip easily and have a good surface. Graphite was also used, and in some of the foundries graphite was mixed with clay. Graphite gave off less gas than the ordinary charcoal blacking, and it was a question whether the rapid volition of a large quantity of gas was good or otherwise, because an excess of gas must be provided for in the venting of the mould. Blacking was not a cheap article, and if the facing of a mould could be done with a material which evolved less gas and prevented the metal from burning into the sand and gave a good skin, a further reduction in the cost would be achieved.

Attention was also being devoted to the idea of utilising waste heat. He did not propose to show how this could be done. It had been attempted, but without any success. The casting of bronze and brass was also receiving considerable attention, with a view to fuel economy. Some of the latter furnaces for moulding these metals had not met with the favour which was anticipated. Personally, he thought the furnaces with high-pressure gas held out more hopes of economy than most of those suggested up to the present.

Organisation was another feature which claimed their attention in the foundries. As the foundries of twenty years ago were anything but pretty, and the same might be said of some of the foundries of the present day, organisation and economy in the handling of metals deserved the attention of those who controlled the foundries.

Discussion.

Mr. J. Weir, junr., said a great deal of the success of the foundry lay with the men in charge, but very often the defects in the castings were due to some carelessness on the part of the workmen. By a little foresight and experimenting, these difficulties could be overcome; also, in the same way, a cheaper iron could be employed and better results obtained.

Mr. J. C. Carmichael, sen., said he did not agree with the President that it would be possible to get a local sand suitable for all castings, but he thought the general practice was to locate the foundries where a supply of suitable sand and metal could be obtained cheaply and easily. No doubt there was more and better machinery to-day, and this all tended to economise time, which meant money.

Mr. J. Matthews said the question of getting sand locally was one which deserved their consideration, and he thought that the foundries in the North of England should unite in considering this matter, and employ some expert to examine the various local sands. The chief requirements in a moulding sand were cohesiveness, porosity, and refractoriness, and by concerted action they might get a local sand with all these qualities cheaper than they could get the sand by rail.

Mr. Weir replied that regarding Belfast sand and Erith sand, the Erith loam was either too light or too heavy, chiefly due to bad mixing by the moulders. In the Midlands very big castings were made in green sand, but if the moulders in the North of England were asked to produce castings from 15 to 30 tons in green sand they would stand aghast at the proposal. He had found where they had defective castings, by reducing the strength of the loam, they got not only strong castings, but a clean skin.

The Chairman, replying to the discussion, said that what he had in his mind in regard to sands was that many foundries were situated with a sand bank on one side of them and a bank of clay on the other. These sometimes had to be removed for developments, which was a costly process, but if some genius could tell them what to do with the sand and clay in order to make it a valuable moulding preparation, a very desirable end would have been achieved.

Correspondence.

Reducing Pattern Costs.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—With reference to the discussion on the Paper "Reducing Pattern Costs," published in your last issue, it is surprising that no mention is made of Keene's cement as a material for hardening plaster-of-Paris, and also of retarding the time taken for this to set. It's use is an advantage where large surfaces have to be strickled to shape.

If desired, Keene's cement can be used alone, and sets as hard and is about as brittle as earthenware.

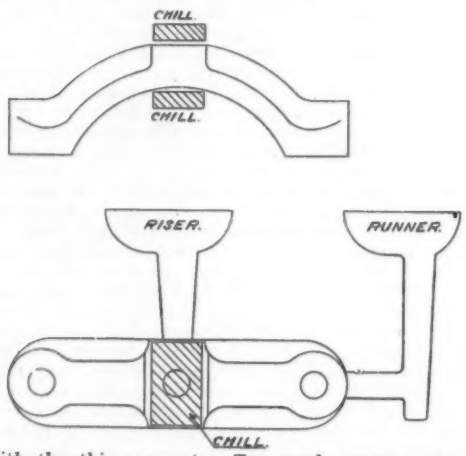
Yours, etc.,
JOHN R. MOORHOUSE.

Manchester.
December 16, 1913.

Queries.

Castings to Stand Pressure.

Answer to Query in November Issue.—"T. B." is troubled with unequal thickness, not so much as to mixtures, but liquid shrinkage; the thicker part cools last and becomes porous, the defect not showing up until machined. If he will place two pieces of iron ½ in. by 2 in. by 3 in. at either side of the pattern (as shown on sketch) ram them up in the mould, withdraw the pattern and oil these chills before casting, this will assist the heavy part to cool equally

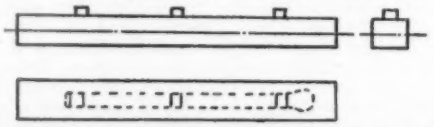


with the thinner parts. Too much scrap must not be used in the mixture, or else trouble will arise in machining. The sketch will explain the best way to cast these castings.—"F. C. B."

[NOTE.—This remedy, we understand, has overcome our correspondent's difficulties.—EDITOR.]

Casting Rain Pipes.

The sketch herewith represents a length of rain pipe. In casting this class of work, such as the top



spouting, rain pipes, and soil pipes, is the iron poured into the moulds from three separate hand ladles or from one end as indicated by the dotted lines above? Also, what iron should be used for the above class of work?

Answer.—The mould in such cases is always poured from three ladles. The metal is usually a mixture having a large proportion of Scotch pig with a high percentage of phosphorus, say, about 1.2 to 1.5 per cent., silicon 2.5 to 3 per cent., sulphur 0.03 to 0.05 per cent., total carbon about 3 per cent., and manganese about 0.3 to 0.5 per cent.

Swept Core Barrels for Steel Castings.

Having had some trouble with swept cores in steel castings, I should like advice as to mixings of sand and also methods of making.

Answer.—We believe core barrels are only used for steel castings when other methods, such as core irons, are impracticable, this owing to the rapid and excessive contraction of steel. Also, the facings for steel moulds and cores are generally of steel-moulder's "compo," obtainable from most first-class foundry-supply firms.

[Answers to this query are solicited from readers. —ED.]

Tar-Sand for Steel.

Can you give a mixture and method of making same, for tar-sand steel moulding?

[Answers to this query are solicited from readers. —ED.]

Foundry Traders' Association.

With a view to generally putting the foundry-equipment and supply trade on a higher basis, a movement has been set afoot to establish a greater degree of unity among foundry-supply manufacturers and traders, for the protection of their own interests collectively, even though they may be competitors individually. At present there is no body which can be considered as absolutely representative of the whole trade, and it is proposed to form a new society with aims likely to be congenial to all branches. There are many matters which need the deliberation of a representative body, in which no one class of trader should feel subservient to another. Steps have already been taken for the formulation of such a society and the scheme is being rapidly developed. Manufacturers and sellers of anything appealing for use in the foundry will be eligible for membership; in fact the body will be made as comprehensive as possible. A meeting was held on Tuesday afternoon, December 23, 1913, at the offices of Messrs. Murphy, Stedman & Company, Limited, 180, Gray's Inn Road, London, W.C., which was attended by representatives or otherwise supported by a number of important firms. Mr. T. Murphy was elected as chairman. The proposals for the formation of a society was most favourably received and promise of strong support was given from various influential sections of the trade. The nucleus of a representative managing committee was formed and it was decided that for the present the work of the new society should be modelled somewhat on the lines of various other trade associations, in order to assist in the promotion of a really representative foundry-trade exhibition when the moment is ripe (securing to members preferential positions, lower charges for space, etc.), to give assistance and to encourage and protect the general trade interests of members, and wherever possible to supply to members any information obtainable as to new business openings throughout the world. The amount of subscription for membership was not fixed, but will be merely a nominal sum so as to secure the active co-operation of all in the trade. Any firms interested in the movement are invited to commuicate with Mr. T. Murphy.

McLain's Semi-Steel.

An interesting booklet issued by the McLain's System, Goldsmith Building, Milwaukee, Wis., U.S.A., contains, amongst other things, a number of blank forms which will be found very convenient for recording data regarding pig-iron, coke, and foundry mixtures. In connection with the McLain system, it may be recalled that at the recent Foundrymen's Convention held in Chicago, a most interesting collection of castings was exhibited made by foundrymen following McLain's system. These included motor-car six-cylinders cast *en-bloc*, four-, two- and one-cylinder castings, containing 25 to 30 per cent. steel scrap. Only a few years ago the motor-car cylinder founder laughed at the idea of using steel scrap in his cylinders, but the semi-steel cylinders containing such a high percentage of steel scrap could not but prove of great interest to all concerned in the work. To-day many are using a small percentage of steel, but those following McLain's system appear to be able to use very much higher percentages. All the castings above-mentioned were cut into sections to show the solidity of the metal where unequal sections joined. There were no blowholes and no sponginess, which supported the claim that when melted scientifically, semi-steel is one of the best metals that come from the cupola. A notable feature was the thin sections in some of the pistons, one in particular being only 3/32 of an inch thick. This light section is possible owing to the fact that the metal is extremely tough and strong.

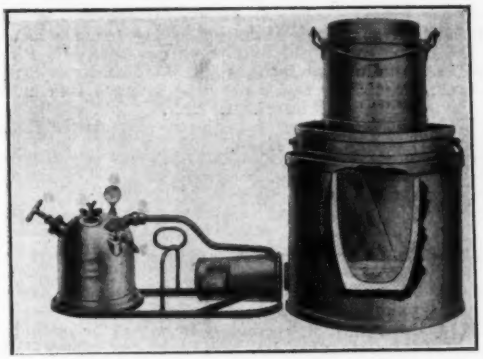
Piston rings made by the Cumberland Foundry and Machine Company, Nashville, Tenn., were the cause of much comment. These rings were of a dense-grained metal, with much spring and elasticity, and those who examined them invariably tried to break them, but without avail. Locomotive pistons and piston rings with 33 to 40 per cent. of steel in their composition were on view. Motor-car flywheels were shown cast of the same 30-per-cent. steel metal as the cylinders, and were perfectly homogeneous at the intersection of heavy and light sections, being of close, dense metal with no sponginess or porous spots. Bevelled gears cut into sections were also shown, the grain of the metal closely resembling steel. Rocker arms, small and large gears, which were formerly made of steel, were shown made of semi-steel, and at a lower cost than the best grey iron. As an example of the regularity of this metal, we understand that one foundry which uses it pours from 1,150 to 1,400 motor-car cylinders per day. In view of the castings on exhibition it is not surprising that many chief engineers, machinists, and others requested that particulars relating to McLain's system be forwarded to the foundrymen who were making their castings.

Northampton Polytechnic Institute.

The annual prize distribution and students' conversazione of this Institute was held on Friday, December 5, when Mr. Cyril S. Cobb, M.V.O., J.P., Chairman of the London County Council, distributed the prizes and certificates for the session. The conversazione for members and students was continued on Saturday, December 6, when the building was thrown open to the whole of the members and students and their friends. Demonstrations and lectures formed interesting features of what proved to be an extremely pleasant function. It may be noted that this Institute accommodates the monthly meetings of the London Branch of the British Foundrymen's Association.

Oil-Fired Brass-Melting Furnace.

The accompanying illustration shows a small furnace which burns common paraffin or kerosene and is particularly suitable for melting brass, copper, aluminium, gold, silver, and zinc. It has the advantage over some other furnaces that it is always ready for use, and when not being used with the muffle the furnace can be used for other heating purposes. It is strictly an oil-blast furnace and muffle combined and at present is made in four sizes, viz., 10 lbs., 20 lbs., 30 lbs., and 50 lbs. respectively.



Oil-fired Brass-melting Furnace.

The furnace is placed on the market by Messrs. Murphy, Stedman & Company, Limited, 180, Gray's Inn Road, London, W.C., who claim for it that when melting small quantities of metal it is much cheaper than a coke furnace, and also quicker and cleaner. The construction will be seen from the illustration. The furnace is fitted with a powerful burner, and the reservoir holds sufficient oil to melt a charge of metal without having to stop to refill. For larger installations a furnace to burn crude oil, worked in connection with a blower, an air compressor or steam is recommended.

Water Softener Amalgamation.

Intimation of an important combination of leading makers of water softeners in the United Kingdom is contained in the announcement that arrangements have been concluded under which the two concerns of Lassen & Hjort, and Water Softeners, Limited, will henceforth operate in the British Isles as a joint concern under the title of United Water Softeners, Limited. Messrs. Lassen & Hjort are well-known as the patentees of one of the most successful modern systems of softening water by means of lime and soda. Messrs. Water Softeners, Limited, are the proprietors of the recently introduced "Permutit" regenerative process. This process, which has been much discussed, is chemically one of very great interest, but the fact that such experts as Messrs. Lassen & Hjort have become identified with it shows that even in the short time it has been before the public, its revolutionary methods of treatment have gained acceptance, and that it possesses a future of promise. As a matter of fact, experience and comparison of the two methods working in competition have established the remarkable fact that, so far from being mutually exclusive or antagonistic, the two processes are in a very large number of cases essential complements one of the other. For the present business will be carried on at the existing offices of the two concerns jointly.

Inventions.

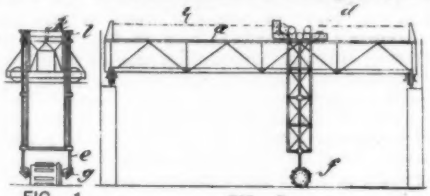
Applications for Patents.

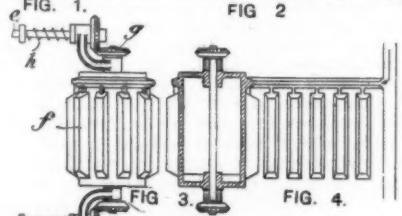
An Asterisk indicates that a complete specification accompanies the application. When inventions are communicated the names of the communicators are in brackets.

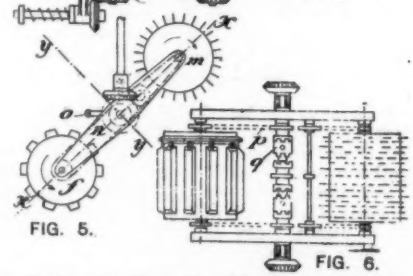
25,900. Distribution of the gases in a gas furnace. J. R. Capper and A. H. Williams.
25,999. Apparatus for charging furnaces. H. N. Leask.
26,026.*Flux for aluminium and its alloys. J. C. Gelly.
26,033.*Stationary drying-kilns for foundries for drying moulds and cores in drying chambers. G. Piron.
26,034.*Portable drying-kiln for drying foundry moulds and cores either on the casting spot. G. Piron.
26,218. Metallurgical furnaces. A. Williams.
26,583. Regulating and controlling temperatures in the melting of metal. I. Hall.
26,712. Impregnation of iron, steel, and cast-iron with nickel. A. C. Hyde.
27,141.*Process of treating metals. J. A. McLarty.
27,405. Alloy for bearings. A. Oxley and D. Davies.
27,406. Alloy for white metal goods. H. Wilkins.
27,525. Manufacture of chrome steel. J. Buchel (Germany.)
27,544. Process for producing castings in iron, etc. H. Pearce.
27,600. Furnaces for heating air for foundry drying-stoves. W. Mayer.
27,678. Reversible regenerative furnaces for manufacture of steel. J. S. Atkinson, Coke Oven Machinery Company, Limited, and K. Huessener.
27,915. Sand for moulders' use. A. N. King and F. Holmes.
27,964. Hot working iron and iron alloys. (International Metal Products Company, United States.)
27,966. Metallic iron and alloy product, and process of manufacturing same. (International Metal Products Company, United States.)
28,048.*Reheating-furnaces. F. K. Siemens.
28,049.*Regenerative gas furnace. F. K. Siemens.
28,060.*Device for dressing castings. T. Stiegelmeyer.
28,061.*Hardening articles of iron or steel. P. Orywall and Gebr. Bauer.
28,097. Salt bath furnaces. S. N. Brayshaw and E. R. Brayshaw.

Abstracts of British Patent Specifications recently Accepted.

5,725 (1913). *Making Moulds for Pig-iron.* Professor H. Aumund, Technische Hochschule, Danzig-Lanfuhr, Germany.—As will be seen from Fig. 1 the device for preparing the moulds is mounted on a traverser *a* that can travel over the casting bed, and consists of a travelling crab *d* to which a drum *f*, that can be raised and lowered, is suspended on rods *e*, so that it can not only adapt itself to the height of the casting bed, but be entirely removed. The suspension rods also rotate the drum through the medium of the bevel wheels *g*, so that the drum which has elevations on its surface for rolling out the pig-moulds is positively rotated. The drum is pressed down to the casting bed by means of springs *h*, so that slight differences of height are compensated by the resilient seating. The rotary movement of the drum is made dependent on the movement of the travelling crab, a chain *i* being fixed at the ends of the crane around a chain sprocket *k*, which, when the travelling crab moves, is rotated, its rotary motion being transmitted to the suspension rods through a pair of bevel wheels *l*. The effect of this is that the drum can be carried repeatedly over the casting bed for effecting better formation of the pig moulds and the form pieces fit again reliably into the already partially formed moulds. In Figs. 5 and 6 an arrangement of the casting device is illustrated, in which the rotary motion of the two suspension rods is not utilised only for rotating the drum in order to impress the moulds, but for rotating a drum *m* furnished with teeth for preparing the sand, the two drums being mounted on a balance beam *n* and being capable of adjustment either as indicated by the line *x x* when the moulds are to be impressed or as indicated by the line *y y* when the preparing or dressing drum is to be employed. The balance beam is held in its position at any time by a catch *o*. The rotation of the two drums results from the movement of the travelling crab, it being







Device for Preparing Moulds for Pig-iron.

supposed according to Figs. 5 and 6 that the rotation of the drums is effected by means of chain-gear *p*, which can be put out of engagement according to requirements.

25,251 (1912). *Process for Dephosphorising Pig-iron.* A. François, 55, rue du Faubourg Raines, Dijon (Dept. of Côte d'Or), France.—In carrying the invention into effect the iron oxide in any form, for example, as ore or scale, and the lime reduced to the state of powder sufficiently fine to pass through the tuyéres and to be carried along by the air, is blown into the fused metal by means of an air blast. The proportion of iron oxide to the lime blown in may be varied so as to obtain slag of a determined composition, and in accordance with the composition of the cast iron treated and the hardness of the metal it is desired to produce. The slag is periodically removed by the usual means. In the place of lime, magnesia or a natural or artificial mixture of lime and magnesia, or a simple or complex carbonate of these two bases may be employed. The employment of carbonate of lime or of magnesia is particularly to be recommended when cast iron having a tendency to work too hot is being treated in the converter. By this process all the phosphorus is converted into phosphate, is retained in the slag, and can be removed therewith. The technical advantages resulting from this process are to some extent due to the avoidance of overblowing, the metal being dephosphorised irrespective of its degree of carburation. This effect is accounted for by the following consideration:—The oxide of iron injected with the blast rapidly converts the phosphorus in the iron into phosphoric acid, and the latter, in consequence of the lime, introduced simultaneously with the iron oxide, passes into the slag in the form of calcium phosphate, the slag thus acting as an eliminator of phosphorus.

Trade Talk.

WOOLNOUGH, LANG, LIMITED, engineers, have removed to Wales Farm Road, Acton, London, W.

MR. J. KING, chairman of the National Light Castings Association, has removed to 142, St. Vincent Street, Glasgow.

MESSRS. DOUGLAS INGRAM & COMPANY have acquired the business of Messrs. Geo. Dunn & Company, engineers, of Dewsbury.

THE Newcastle-on-Tyne office of Guest, Keen & Nettlefolds, Limited, has been removed to St. Nicholas Buildings, 12, Westgate Road.

FARRINGDON WORKS & H. PONTIFEX & SONS, LIMITED, have removed from 46, Shoe Lane, London, E.C., to Pontifex House, 43 and 44, Shoe Lane, E.C.

MESSRS. F. H. PRENTIS AND J. P. HAWKES, carrying on business as engineers and manufacturers, at Roden Street, Ilford, under the style of Packer & Prentis, have dissolved partnership.

THE RICHMOND IRONWORKS, Bowesfield Lane, Stockton, covering four acres, have been offered for sale by public auction, but the only bid was one of £3,000, and the property was consequently withdrawn.

THE CANADIAN UNITED MANUFACTURERS' AGENCY, 12, Charterhouse Buildings, Goswell Road, London, E.C., have been appointed British agents of the James Smart Manufacturing Company, Limited, Brockville, Ontario.

THE fourth May lecture of the Institute of Metals will be delivered by Prof. Heyn, of Berlin, who will take for his subject "Internal Strains in Cold-wrought Metals and Some Troubles Caused Thereby."

THE partnership heretofore subsistng between Messrs. F. W. Hirst and T. Walker, carrying on business as engineers, at 32, Lees Street, Ancoats, Manchester, under the style of Thomas Walker and Company, has been dissolved.

MR. F. L. MITCHELL, formerly of Dalmally, Ayr, has retired from the firm of Mitchell & Dewar, engineers, 164, Howard Street, Glasgow. Mr. R. D. Dewar continues the business on his own account at the same address.

MESSRS. W. H. FORTUNE, A. RUSHWORTH, and H. POLLARD, carrying on business as machine tool makers, at the Fairfield Ironworks, Holmfield, Halifax, under the style of Fortune, Rushworth & Pollard, have dissolved partnership.

THE estates of William Young & Sons, engineers, Ardrossan, and W. Young and R. L. Young, both engineers, residing at Ravenscraig, Ardrossan, the individual partners of the firm, have been sequestrated by the Sheriff of Aryshire, at Kilmarnock.

MESSRS. E. P. MARLEY AND W. E. MARLEY, carrying on business as locksmiths, brassfounders and general architectural metal workers, at Viaduct Works, Thimble Mill Lane, Aston, Birmingham, under the style of Marley Brothers, have dissolved partnership.

THE partnership heretofore subsisting between Messrs. W. H. Benson and A. Tipling, formerly carrying on business as hydraulic and general engineers and millwrights, at Westfield Iron Works, Wesley Street, Morley, under the style of Waring, Tipling and Benson, has been dissolved.

MESSRS. F. W. LENNARD, T. W. LENNARD, and G. A. COOPER, carrying on business as ironfounders, smiths, and metal workers, at 34, Eagle Street, St. Andrew, Holborn, London, under the style of Harold Cooper and Company, have dissolved partnership, so far as regards MR. G. A. Cooper

WE are informed that the firm of C. P. Sandberg, consulting and inspecting engineers, Palace Chambers, 9, Bridge Street, Westminster, London, S.W., will be continued under the same title by Messrs. P., A., & N. Sandberg, the sons of the late Mr. C. P. Sandberg, who were partners with him for many years.

THE copartnery of John D. Mackenzie and Wright, engineers and agents, 199, St. Vincent Street, Glasgow, was dissolved as at August 31 last, by the retirement of Mr. James Wright. The remaining partner, Mr. John Donald Mackenzie, will continue the business in his own name at 199, St. Vincent Street, Glasgow.

THE shareholders of the Falcon Iron Works, Limited, have passed a resolution to the effect that the Company cannot, by reason of its liabilities, continue its business, and that it is advisable to wind up the same, and accordingly that the Company be wound up voluntarily. Mr. H. Bayly, 1, Booth Street, Manchester, has been appointed liquidator.

Messrs. George Green & Company, foundry engineers, Keighley, are supplying the complete foundry melting equipment for the new Liverpool foundry of Messrs. Harland & Wolff, Limited, which includes four of their well-known rapid "Economic" cupolas, one of 4-tons, two of 6-tons, and one of 10-tons per hour capacity, together with motor-driven blower, etc.

MR. ALBERT VICKERS proposes to endow a fund for the presentation each year of a gold medal and a premium in books or instruments for the best paper read by a member of the Junior Institution of Engineers. This prize, Mr. Vickers states, is to commemorate the occupancy of the presidential chair during the past year by his friend Sir Trevor Dawson, and to show his appreciation of the good work being done by the Institution. It has been decided that the medal should be known as the "Vickers Gold Medal of the Junior Institution of Engineers."

IN a letter addressed to the debenture stockholders of Messrs. Robert Stephenson & Company, Limited, of Darlington, Sir William B. Peat, receiver and manager, states that he has been directed by the Court to place before the shareholders the terms of a provisional agreement entered into for the sale of the Darlington works. It appears that since his appointment as receiver and manager in July, 1909, the business of the Company at Darlington has been successfully carried on. The net profits earned since July, 1909, have been as follows:—From July 9, 1909 to December 31, 1909, £1,293; year ended December 31, 1910, £3,920; year ended December 31, 1911, £1,766; year ended December 31, 1912, £10,994; making a total of £17,973. The rent of the Hebburn Works, paid by Palmers' Shipbuilding and Iron Company, Limited, amounting to £5,000 per annum, is not taken into account in these figures. For the current year it is estimated that the profit from the Darlington works on the basis mentioned above will amount to about £25,000. Sir William B. Peat has been in negotiation with various parties for the sale of the Darlington property, without result, and he has decided, from his experience of the engineering trade, that any attempt to realise these works at the present time at a satisfactory price by public auction would not only be fruitless and a waste of money, but would tend to damage seriously the value of the goodwill of the business. In order to close the receivership, it is proposed that a company be formed with an authorised capital of £275,000, divided into ordinary shares of £1 each, to take over the Darlington works and the other unrealised assets. As consideration of the sale, the new company will take over all liabilities ranking in priority of the 4 per cent. debenture stock, including moneys borrowed by the receiver, trade liabilities, and the costs of the proceedings in Chancery, and will allot all the share capital, less the seven shares to be taken by the subscribers to the memorandum of Association. The Industrial and General Trust, Limited, who are holders of a large amount of 4 per cent. debenture stock, have undertaken to form the new company, and to procure for it advances up to £100,000 in order to discharge the liabilities referred to above, and to provide it with about £20,000 working capital. The first directors of the new company will be Mr. Walter Benton Jones, of Treeton Grange, Rotherham; Mr. William Wingfield, of 2, Ryder Street, St. James's, S.W.; Mr. Clarence Noel Goodall, of Darlington (the present general manager of the works), and Sir William B. Peat, of 11, Ironmonger Lane, E.C. The necessary resolutions have been adopted.

Deaths.

MR. F. MARTIN, ironfounder, Newbury Lane, Rounds Green, Oldbury, Birmingham, died recently at the age of 59 years.

THE death is reported of Mr. E. Trounson, of the Redruth Foundry Company, Limited, of Redruth, Cornwall, at the age of 63 years.

THE death took place recently of Mr. E. Houson, of Messrs. Howarth & Houson, brassfounders, Birmingham, at the age of 71 years.

THE death has occurred of Mr. F. Davy, a director of the firm of I. Davy & Company (Elsecar), Limited, ironfounders, Elsecar, at his residence in Wath Road, Elsecar.

MR. J. LLEWELLIN, at one time associated with the firm of Llewellin & James, engineers, Bristol, died recently at the age of 72 years. The deceased gentleman retired from business about 30 years ago.

THE death has occurred at Handsworth of Mr. David Andersons, aged 91. He was the last of the famous engineers engaged by Messrs. Watt & Boulton at the Soho Foundry. He had control of the engines made for the "Great Eastern" steamship.

THE death occurred at 10, Holmlea Road, Battlefield, Glasgow, on December 10, in his 34th year, of Mr. Duncan Paterson Campbell, of the Campbell Gas Engine Company, Limited, the only son of Mr. James Campbell, 11, Hampden Terrace, Mount Florida, Glasgow.

MR. JOSEPH BENNET, of the firm of Alder and Mackay, gas meter manufacturers, brassfounders, etc., New Grange Works, 36, Stewart Terrace, Edinburgh, died on December 12, aged 78 years. The deceased had been connected with the firm for about 40 years, and was to a large extent instrumental in securing for it the prominent position it enjoys.

MR. WM. MARTIN died on December 12 at his residence, Claremont House, Coatbridge, aged 68 years. The deceased gentleman was head of the firm of William Martin, Dundyvan Iron and Steel Works, Coatbridge, and had only been ill for a fortnight. He was one of the two ironmasters in the Coatbridge district who refused to join the Scottish Association.

THE death of Mr. G. E. Maddock, of the firm of John Maddock & Company, Limited, ironfounders, Great Western Works, Oakengates, Salop, took place at his residence, Parkdale, Wolverhampton, on December 19. The deceased was 46 years of age. He was a son of the late Mr. John Maddock, who at one time resided at Admaston, near Wellington, and was a director of the business which his father founded at Oakengates, now one of the most flourishing industries in the district. The late Mr. George Maddock for some years represented the firm abroad.

MR. WILLIAM YEOMANS, of Otterford, Haden Hill, Halesowen, died recently. He was born at Kinver on February 2, 1833, and for ten years was manager of the Hyde Works, Kinver. When these works were closed down he was appointed by Messrs. Hingley & Son, and served under the late Sir Benjamin Hirgley in the capacity of manager. In 1882 the Old Hill Ironworks were commenced, and the deceased gentleman was the first manager. He held the position until a few months ago, when he was seized with illness. Mr. Yeomans was for ten years the secretary of the South Staffordshire Iron and Steel Institute, and his services were recognised when he resigned in 1890 by a presentation. In 1896 he was selected to take the presidential chair of the Institute.

WE greatly regret to announce the death of Mr. C. P. Sandberg, M.I.C.E., whose sections of rails bear his name, and are widely known both in this country and abroad. Mr. Sandberg was born in Sweden on October 8, 1832, and completed his technical education in that country, where he was connected with various blast furnace plants and other works for several years. He received the premium from the Swedish Iron and Steel Association, and on its behalf went to Germany, Belgium, Spain, and elsewhere to study the manufacture of iron and steel. He first came to England in 1860, having been appointed by the Swedish Government Railways to inspect rails bought for them in this country; that appointment he retained until his death. After some years in England in this capacity he began to practice as consulting and inspecting engineer in Westminster, and his work in connection with rails and permanent way generally soon secured for him an international reputation. He became a member of the Institution of Civil Engineers in 1866, and two years later was awarded the Telford gold medal and a premium for his paper on "The Manufacture and Wear of Rails." His sections of rails known as the Sandberg sections were first introduced in 1878, but a later design was brought out in 1894. They were soon in demand, and some millions of tons have been made. More recently he introduced what became known as Sandberg silicon steel rails, which are also widely used, and in 1907 presented a note on the subject, entitled "The Chemical Composition of Steel Rails and Latest Developments," for discussion at the Engineering Conference of the Institution of Civil Engineers. From the beginning of railways in China Mr. Sandberg was connected with most of those built under British auspices in the capacity of consulting and inspecting engineer, and more recently he had occupied a similar position for the Government of Siam. In addition to the Institution of Civil Engineers, Mr. Sandberg was a member of the Iron and Steel Institute, the Institution of Mechanical Engineers, the French Institution of Engineers, and other technical societies. He was also the author of many papers on permanent way, dealing more especially with rails, and for his expert services received decorations from Sweden, Belgium, Russia and China. Mr. Sandberg has been assisted in his work by his three sons, who have been his partners for many years.

Personal.

THE late Mr. John William Sankey, of Wolverhampton, chairman of Joseph Sankey & Sons, Limited, left estate of the net value of £49,875.

THE late Mr. D. MacFie, formerly a director of James Milne & Son, Limited, engineers, of Edinburgh, left personal estate of the value of £5,602.

MR. DOUGLAS VICKERS, a director of Vickers, Limited, has announced his withdrawal from the prospective candidature for the Brightside Division of Sheffield.

MR. E. E. ECCLES, resident manager for the British Aluminium Company's works at Foyers, has been appointed assistant general manager to the company in London.

THE late Sir William Henry Preece, formerly engineer-in-chief and electrician to the General Post Office, left estate valued at £32,320 2s. 2d. gross, and £22,074 17s. 10d. net.

MR. WILLIAM JOHNSON GALLOWAY, of Manchester and London, has been elected chairman of the Carnforth Hematite Iron Company, Limited, in place of the late Mr. Edward Barton.

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS has awarded to Mr. G. Westinghouse the Grashof medal, for obtaining the most important results in engineering during the past 12 months.

THE late Sir Charles T. Skelton, a director of C. T. Skelton & Company, Limited, edge tool manufacturers and engineers, of the Sheafbank Works, Sheffield, left personal estate valued at £33,880.

DR. R. MOLDENKE and MR. W. WOOD, both of the United States, have been in London in connection with the Committee on Specifications for Pig-iron and Castings of the International Association for Testing Materials.

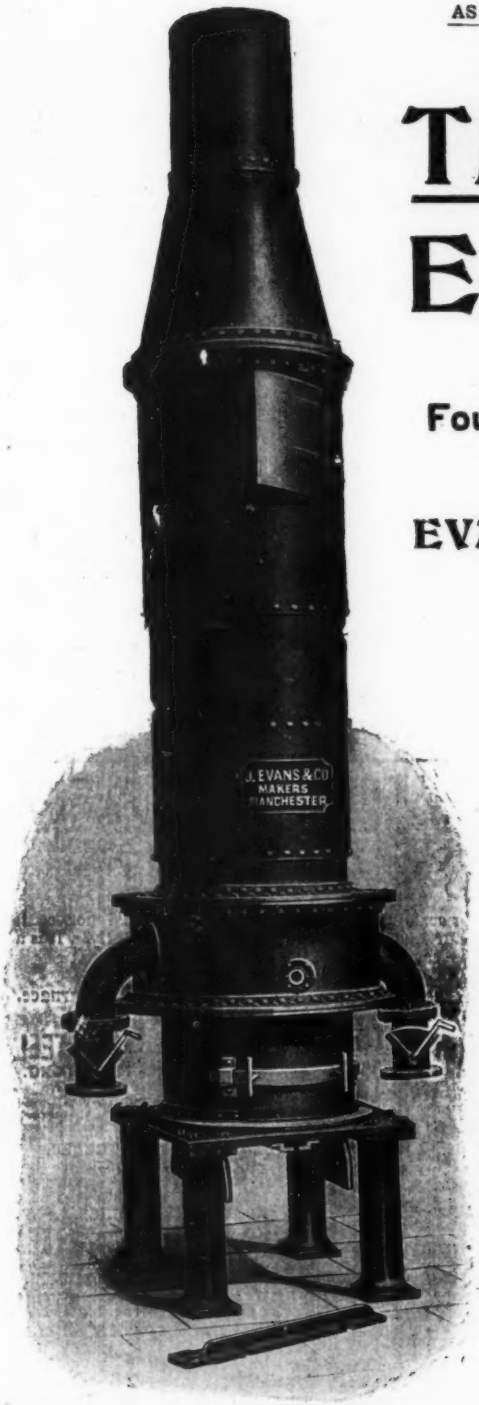
THE will of the late Mr. Edward Barton, J.P., of Warton Grange, Carnforth, near Lancaster, the founder of the Workington ironworks, and late of the Carnforth ironworks, with which concern he was identified for 50 years as director and chairman, has been proved. The net personalty has been sworn at £72,322 3s. 6d.

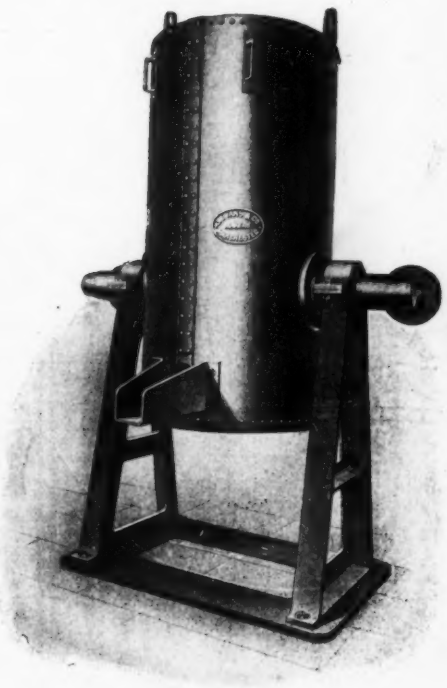
AS SUPPLIED TO THE ADMIRALTY, WAR OFFICE,
COLONIES, AND FOREIGN GOVERNMENTS.

THE Cupola.
Evans's Rapid.

Foundries Completely Furnished.

EVANS'S NEW CUPOLETTE
For Emergency Work.





James Evans & Co.,
Britannia Works,
Blackfriars,
MANCHESTER.

Telegrams: "LADLES, MANCHESTER."

New Companies.

WILTON ENGINE COMPANY, LIMITED.—Capital £2,500 in £1 shares.

CRUISER ENGINEERING COMPANY, LIMITED.—Capital £1,000 in £1 shares.

TEXTILE ENGINEERING COMPANY, LIMITED.—Capital £10,000 in £1 shares.

EDWARD HOLLINGWORTH & COMPANY, LIMITED.—Capital £2,000 in £1 shares, to carry on the business of engineers.

ENGINEERING AND MERCANTILE COMPANY, LIMITED.—Capital £10,000 in £1 shares (6,000 seven per cent. participating preference).

GARNISH, LEMON & COMPANY, LIMITED.—Capital £4,000 in £1 shares, to carry on the business of agricultural implement manufacturers.

SHAW'S (WILLENHALL) LIMITED.—Capital £2,000 in £1 shares, to carry on the business of brass casters. Registered office: St. Anne's Road, Willenhall.

COX BRASS MANUFACTURING COMPANY, LIMITED.—Capital £5,000 in £1 shares. J. J. Weldon is the first permanent director. Registered office: 135, Wellington Street, Glasgow.

ALBION IRON AND STEEL COMPANY (TIPTON), LIMITED.—Capital £2,000 in £1 shares (1,000 preference). The subscribers are: A. C. Parson, 3, Dudley Port, Tipton; G. S. Parson, 3, Dudley Port, Tipton.

BERRY & HARTLEY, LIMITED.—Capital £600 in £1 shares, to carry on the business of founders, engineers, etc. W. W. Hall is the secretary. Registered office: Railway Foundry, Tottington, near Bury.

W. S. JEAL & COMPANY, LIMITED.—Capital £550 in 500 preference shares of £1 and 1,000 ordinary shares of 1s., to carry on the business of engineers. Registered office: 17, Chryssell Road, North Brixton, London, S.W.

PETER CARMICHAEL & COMPANY, LIMITED.—Capital £5,000 in £1 shares, to carry on the business of engineers and millwrights. Sole director, M. S. Carmichael. Registered office: 4, Carr Street, Limehouse, London, E.

HENRY RISHTON, LIMITED.—Capital £5,000 in £1 shares, to take over the business of iron moulders and founders carried on by Messrs. R. Rishton, E. Rishton, and A. Rishton, at Kendal as Henry Rishton. The first directors are F. Rishton and P. C. Gordon.

ROBERT SEMPLE & COMPANY, LIMITED.—Capital £2,000 in £1 shares (1,400 preference), to carry on the business of engineers, etc., in Lanarkshire, as carried on by Robert Semple & Company, Limited. The first directors are J. A. Montgomerie, J. B. Stobo, J. S. Steven, R. Semple, J. Meikle and R. Austin, jun.

MIDAS STEEL AND ENGINEERING COMPANY, LIMITED.—Capital £1,000 in £1 shares, to take over the business of engineers and ironfounders carried on at Leeds Road, Attercliffe, Sheffield, as Worrall, Smith & Akeroyd. The first directors are: H. Smith, S. Akeroyd, and P. R. Hailwood (all permanent). Registered office: Leeds Road, Attercliffe, Sheffield.

W. T. CLARKE & COMPANY, LIMITED.—Capital £2,000 in £1 shares (1,000 6 per cent. cumulative preference), to take over the business of an engineer carried on by W. T. Clarke at 8, New Oxford Street, W.C., as W. T. Clarke & Company. The first directors are W. T. Clarke (managing director) and M. Payne. Registered office: 8, New Oxford Street, London, W.C.

JOHN MCNEIL & COMPANY, LIMITED.—Capital £55,000 in 25,000 5½ per cent. cumulative preference and 29,900 7 per cent. non-cumulative part. preference shares of £1 each, and 1,000 deferred shares of 2s. each, to acquire the business of engineers, etc., carried on by John McNeil & Company, Helen Street, Govan. The first directors are J. McNeil (permanent director and chairman), C. McNeil, W. A. McNeill and R. F. Millar. Registered office: 80, Helen Street, Govan.

A NEW STEEL BARROW

(PATENTED)

"BRABY'S BALANCED BARROW."

The Handiest and Cheapest Barrow in the market. Specially designed for coal, dross, ashes, etc. Its capacity is **25 per cent. greater** than the ordinary style, yet it can be wheeled with **half the labour**, and can be emptied **much more quickly**. It is a **perfectly balanced** barrow, and a full load can be **easily wheeled by a boy.**

NOTE.—This Barrow can be taken right up to mouth of furnace and the ashes drawn into the barrow direct from the furnace.

The "B.B.B."

BRABY for high grade **STEEL**
SHEETS & PLATES up to 15 FEET LONG.
RANGE of GAUGES 8 to 30 W.G.
RANGE of WIDTHS 12 to 60 in.

BRABY for improved wrought **STEEL**
BARROWS. BOGIES, TRUCKS.
GUTTERS. PIPES, &c.

BRABY for Iron and **STEEL**
ROOFS and BUILDINGS.

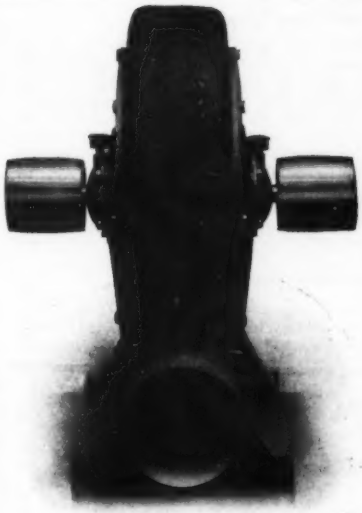
BRABY for unbreakable **STEEL**
SASHES, CASEMENTS, and
PUTTYLESS ROOFLIGHTS.

BRABY for galvanized corrugated **STEEL**
SHEETS: "EMPRESS" & "SUN" BRANDS

FREDERICK BRABY & Co. Ltd., Eclipse Iron & Galvanising Works & Steel Sheet Rolling Mills, Petershill Road, GLASGOW.

Show Rooms and Aluminium Warehouse, 124, St. Vincent Street, Glasgow.
Rustless Iron, Galvanising and Copper Works, FALKIRK.

Also at London, Deptford, Liverpool, Bristol, Belfast and Dublin. CONTRACTORS to BRITISH and FOREIGN GOVERNMENTS. Teleg.—"Braby, Glasgow."



TRADE SIROCCO MARK

CUPOLA FANS.

Made in eight sizes from 10-in. to 35-in. diameter, and suitable for melting ½ to 20 tons per hour at pressures from 12—30 inches Watergauge.

Cast Iron Casings and Ball Bearings.

Double Inlet. All Types of Discharge.

Write for Bulletin No. 2028F.

DAVIDSON & CO., LIMITED,

Sirocco Engineering Works,

BELFAST.

ELDERS FOUNDRY COKE

AS SUPPLIED TO THE BRITISH ADMIRALTY DOCKYARDS.

The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.

From PECKETT & SONS, Bristol.

Bristol, October 25th, 1904.

We have been using your Selected Foundry Coke for some considerable time.
We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, more free from blowholes and other defects, than we formerly did.

From BOW, McLACHLAN & CO., LTD. (Paisley Foundry), Paisley, Glasgow.

Paisley, 12th March, 1909.

We have yours of 4th inst., and in reply have pleasure in stating that we have been using your Foundry Coke for several years for special purposes with highly satisfactory results.

Elders Collieries, Ltd., Cardiff.

PRICES OF METALS.

The following table shows the approximate latest prices and position of stocks of metals during the past two years :—

METALS.	End Dec., 1913.	End Dec., 1912.
IRON—Scotch pig warrants ton	..... *56/-	..... *73/9
—Middlesbro' warrants ton	..... 50/0½	..... 67/10½
—W.C. M/nos Bessemer ton	..... 65/6	..... 86/0
—Stock, Middlesbrough tons	 139,987	 238,571
COPPER—Chili bars GMB ton	..... £65 1 3	.... £77 0 0
—Stock, Europe and afloat tons	 27,118	 43,241
TIN—English ingots.. ton	.....£171 10 0	....£232 0 0
—Straits .. .. ton	.....£169 10 0	....£229 15 0
—Stock, London, Holland U.S.A., and afloat.. tons	 15,543	 11,861
LEAD—English pig .. ton	.....£18 10 0	.... £18 10 0
SPELTER—Ord. Silesian ton	.....£21 11 3	.... £26 7 6
QUICKSILVER (75lb.).. bottle	..... £7 10 0	..... £7 8 6
ANTIMONY—Regulus ton	£28 0 0 £30 0 0	£38 0 0 £40 0 0
ALUMINIUM—Ingot .. ton	£81 0 0 £85 0 0	.... £88 0 0

* Settlement price.

CASTINGS.

In the Cleveland district the following are the nominal rates current for castings :—

	£ s. d.	£ s. d.
Columns (plain)..	7 7 6	to 7 12 6
Pipes, 1¼ to 2½ in.	6 7 6	to 6 12 6
„ 3 to 4 in.	6 0 0	to 6 2 6
„ 5 to 8 in.	5 15 0	to 5 17 6
„ 10 to 16 in.	5 17 6	to —
„ 18 to 24 in.	5 17 6	to —
Chairs	4 5 0	to 4 6 0
Floor plates (open sand)	3 10 0	to 3 12 6

SCRAP.

The quotations for scrap, subject to market fluctuations, are as follows : Heavy wrought (mixed), £2 7s. 6d.; light wrought, £1 5s. 0d.; heavy cast, £2 10s. 0d.; all per ton, f.o.b., London. Copper (clean), £60 10s. 0d.; brass (clean) £37 10s. 0d.; lead (usual draft), £16 5s. 0d.; zinc, £15 15s. 0d.; all per ton delivered merchant's yards.

SOME interesting details of the progress made at the works of the Tata Iron and Steel Company, Limited, are contained in the seventh annual report. The steel works have experienced many difficulties, and have not yet fulfilled expectations. The quality of the steel has improved, and several thousands of tons of rails have been passed by the Government Inspector and have been Three grades of steel are being marketed as "British standard," which carries with it a certificate from the Government Metallurgical Inspector; "bazar," for material which just falls outside British standard specifications; and second class, or steel slightly defective on the surface.

Legal.

Hesketh Steel Castings, Limited.

Counsel has applied to Mr. Justice Sargant, in the Chancery Division, in the matter of Morny v. Hesketh Steel Castings, Limited, in which his lordship made an order recently. Counsel said he represented the North London Railway Company, on whose premises the defendant company carried on their business. His application was to prevent the receiver appointed by his lordship selling the property without first satisfying a debt of £100 for rent to his clients.

His lordship said he would grant an injunction against this, pending a summons. The receiver was not to sell with prejudice to the railway company's claim for rent.

MR. A. E. BREWER, general manager of John Bellamy, Limited, engineers, of Byng Street, Millwall, London, E., has been elected a director of the company.

BLOFIL
THE
IRON CEMENT
(Quick or slow setting grades)
IS
THE CHEAPEST
AND
MOST RELIABLE
for all purposes.
Unaffected by oil, steam, or water.

Sole manufacturers—

RUDD & OWEN
(DEPT. I)
HULL
Telegrams "Theripnene," Hull.
Telephone National 1223.

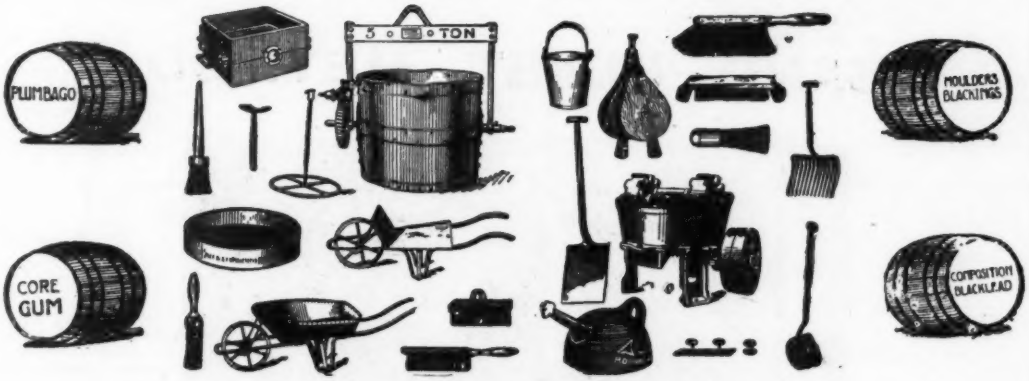
GANISTER, CUPOLA BLOCKS, FIRE BRICKS,
FIRE CLAY.
Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.
STEEL MOULDERS' COMPOSITION, SILICA CEMENT.

J. GRAYSON LOWOOD & Co., Ltd.,
DEEPCAR, nr. SHEFFIELD.
Telegrams: "LOWOOD, DEEPCAR."

Established 1863.

JAS. DURRANS & SONS,

Phœnix Works, Penistone, Near Sheffield.



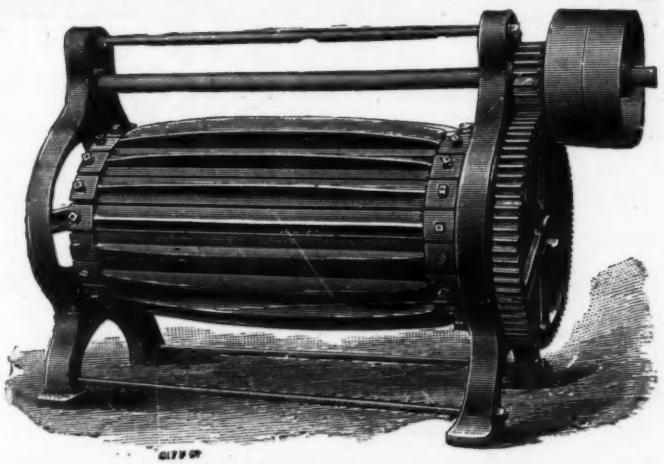
Manufacturers of all

FOUNDRY EQUIPMENTS

COMPOSITION BLACK LEAD, PLUMBAGO, CORE GUM, WHITE DUST & COAL DUST

Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Improved Foundry Rattler or Fettling Drum.



These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.

The following testimonial explains itself :—

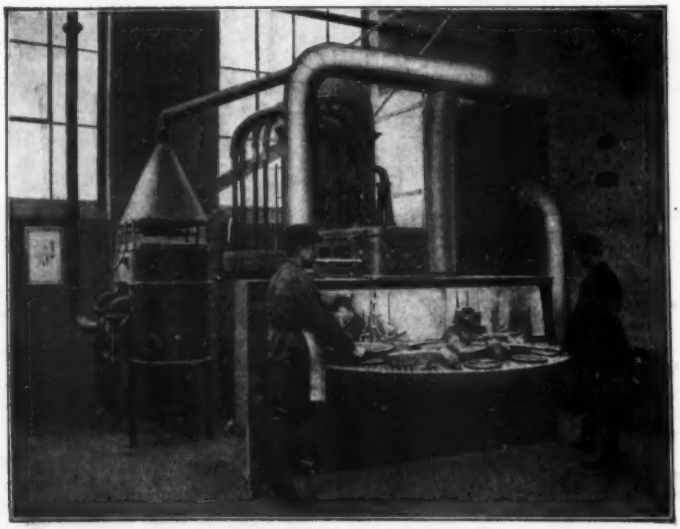
"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD.

CLEAN YOUR CASTINGS

BY THE

SAND BLAST METHOD.



It removes every particle of sand, etc., creates a desirable appearance and an unexcelled surface for machining. Castings, no matter how complicated, are made clean, in the true sense of the word, i.e., free from dirt, foreign or undesirable matter. It **SAVES MONEY**, in fact on lots of work is several times faster than wire brushes, tumbling or pickling with less workmen and less breakages.

Illustrated catalogue of various Sand Blast Machines or detailed information on any special work will be sent free on application.

JAR RAMMING MOULDING MACHINES.

THE LONDON EMERY WORKS Co., PARK WORKS,

TOTTENHAM, LONDON, N.

SITUATIONS VACANT AND WANTED.

FOUNDRY (ALUMINIUM) ASSISTANT FOREMAN wanted. Must be first-class man and accustomed to latest methods of producing High-Class Castings at lowest cost.—Apply, stating age, experience, and wages required, to Box 485, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

MOULDER wants constant job, in or near London; 13 years' experience in marine and general work; life-long abstainer; present job 5 years.—Apply Box 475, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

FOREMAN MOULDER desires change. Experienced in all classes of Castings in Loam, Dry and Green Sand, Iron, Brass, and Steel.—Address "FOREMAN," care of 7, Boston Street, Manchester.

FOUNDRY FOREMAN, conversant with the most modern Foundry Practice, requires situation. Experienced in Green and Dry Sand work. Expert machine. Managed 150 men. Holds three First Class Technical College Certificates. Excellent references and testimonials.—Address Box 484, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

FOR SALE AND WANTED.

TO UTILIZE your OLD SAND, mix, grind, and prepare it at the Lowest Cost by HALL'S INVINCIBLE SAND MIXERS. Universal success. All information free to Foundry Managers.—Apply C. E. V. HALL, Stirling Chambers, Sheffield.

LARGE HYDRAULIC MOULDING MACHINE, by London Emery Works Co., pattern "L," with turnover pattern-plate and hydraulic extraction of patterns to take boxes 3 ft. by 12 in. deep each part. Cost £206 10s. In splendid condition. Can be seen in operation at these works.—PETTERS, LIMITED, Yeovil.

FOR SALE AND WANTED—(*Continued.*)

CORE GUM. ROSIN. CORE GUM. ROSIN.

IT will Pay you to write me for Samples and Prices of EDGAR KENYON, Direct Importer.

5, Carr Street, Blackfriars Street, Manchester.

TO BE SOLD AS A GOING CONCERN, close to the Great Northern and Great Central Railway at Retford (Notts.)

A Grand Opportunity for anyone who is energetic and desirous of a Good, Sound, Old-established BUSINESS, comprising of IRON and BRASS FOUNDRY and MACHINE SHOP, with a good business connection in a fast-growing district. Owner retiring through old age.

Full particulars will be given on application to Box 480, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

FANS AND BLOWERS AND OTHER FOUNDRY MACHINERY FOR SALE.

BARGAINS FOR PROMPT CASH.

No. – Root's Blower "Acme" for 20 smiths' fires.
One ditto, with high-speed Vertical Engine combined.
Thwaites Roots Blower, 11¼" discharge.
"B" Roots Blower by Alldays.
Foundry Blowing Fan, 36" impeller, 10" discharge, also 9¾" round outlet to fit on same.
14" Schiele patent Blast Fan.
Lloyd's patent Blowing Fan for 50 smiths' fires.
New Roots pattern Blower, 5".
Silent Blowing Fans, 8½", 8" and 9" discharge.
Ball Mill, with drum, 2' 7" and 5' 8" outside by 1' 7" wide.
Improved Foundry Core Ovens, portable type and for fixing in wall.
4' 6" diameter UNDERGEARED LOAM MILL, with stationary pan.

CHARLES D. PHILLIPS,

EMLYN & CENTRAL ENGINEERING WORKS, NEWPORT, MON.

FOR A PERIOD OF OVER TWENTY-FIVE YEARS THE REPUTATION OF

FRODAIR SPECIAL PIG-IRONS

has been steadily growing. Their excellence is acknowledged and acclaimed by leading Engineers and Ironfounders, because they are easily **MELTED, CAST** and **TOOLED,** ensure **REGULARITY** and remarkable **DURABILITY,** and shew genuine **SUPERIORITY** and **ECONOMY.**

CYLINDERS, ENGINE PARTS, VALVES, ROLLS (chilled and grain), HYDRAULIC WORK, FIRE AND ACID-RESISTING CASTINGS, MALLEABLE CASTINGS, and other important work *shew a marked improvement when cast with* **FRODAIR IRONS.**

Write for further particulars, etc.,

THE FRODAIR IRON & STEEL Co., LTD.,

FENCHURCH HOUSE, LONDON, E.C.

Telegrams: "Frodair, London."

WHITE METAL LETTERS

Stamped Brass Letters.

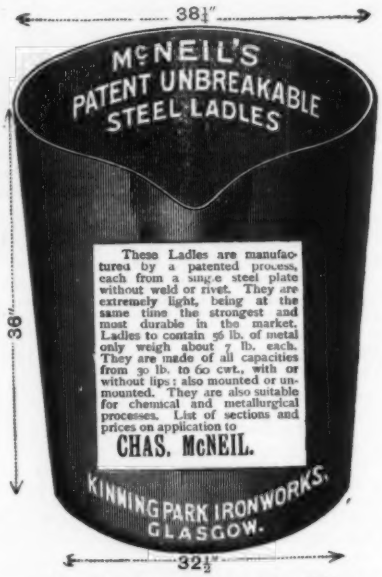
All kinds of Letters for Pattern-making and Foundries supplied from stock at very advantageous prices.

Solid (cast) Brass Letters.

Walton & Co.,

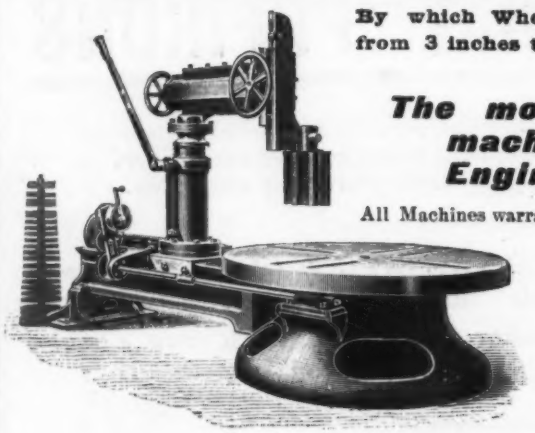
66-68, Slaney Street,

Birmingham.


38¼"
McNEIL'S
PATENT UNBREAKABLE
STEEL LADLES
These Ladles are manufactured by a patented process, each from a single steel plate without weld or rivet. They are extremely light, being at the same time the strongest and most durable in the market. Ladles to contain 56 lb. of metal only weigh about 7 lb. each. They are made of all capacities from 30 lb. to 60 cwt., with or without lips; also mounted or unmounted. They are also suitable for chemical and metallurgical processes. List of sections and prices on application to
CHAS. McNEIL.
KINNING PARK IRONWORKS,
GLASGOW.
38"
32½"

Can also be made in Aluminium.

WHITTAKER'S IMPROVED MOULDING MACHINE



By which Wheels or Pulleys of any description or size from 3 inches to upwards of 20 ft. diameter can be made.

The most complete and efficient machine hitherto introduced to Engineers.

All Machines warranted to Mould with the greatest accuracy and precision.

GEARING WHEELS

Spur or Bevel, Straight Teeth and Double Helical Teeth Supplied to Consumers.

ROPE & BELT PULLEYS.

WM. WHITTAKER & SONS, LTD.,

SUN IRON WORKS, ***OLDHAM.***

Index to Advertisers.

Addresses, Telegraphic Addresses, and Telephone Numbers.

PAGE.	NAME.	ADDRESS.	TELEGRAPHIC ADDRESS	TELEPHONE NO.
	Alldays & Onions, Ltd.	Birmingham	Alldays, Birmingham	28 Victoria
72	Braby, F. & Co., Ltd.	Petershill Road, Glasgow	Braby, Glasgow	—
64	Bradley, T. & I., & Sons, Ltd.	Darlaston	Bradley, Darlaston	—
C. ii.	Britannia Foundry Co.	Coventry	Stoves, Coventry	251
65	British Aluminium Co., Ltd.	109, Queen Victoria Street, S.E.	Cryolite, London	4315 London Wall
73	British Binderit Co., Ltd.	317, High Holborn, London, W.C.	Bindercomp, Holborn, London	950 Holborn
73	Brinck & Hübner	Mannheim, Germany	—	—
C. iv.	Buckley & Taylor Ltd.	Castle Iron Works, Oldham	Engines, Oldham	Oldham No. 8
64	Cumming, William, & Co. Ltd.	Maryhill, Glasgow	Prudence, Glasgow	P. O. M. 25
119	Davidson & Co., Ltd.	Belfast	Sirocco, Belfast	4341 Belfast
	Dempster, R. & J., Ltd.	Oldham Road, Manchester	Scrubber, Manchester	—
63	Davies, T., & Son	West Gorton, Manchester	Tuyere, Manchester	70 Openshaw
	Derby Boiler Co., Ltd.	Derby	Welded, Derby	100 Derby
121	Durrans, Jas., & Sons	Penistone, nr. Sheffield	Durrans, Penistone	—
C. ii.	Dyson, J. & J.	Sheffield	Dyson's, Stannington	702 Sheffield
119	Elders' Collieries, Ltd.	Cardiff	Elder, Maesteg	10
74 & 117	Evans, J., & Co.	Manchester	Ladies, Manchester	2297
118	Everitt & Co.	40, Chapel Street, Liverpool	Persistent, Liverpool	1134 Central (3 lines)
123	Frodair Iron & Steel Co, Ltd.	5, Fenchurch Street, E.C.	Frodair, London	—
118	Fyfe, J. R. & Co.	Shipley, Yorks	Brick, Shipley	59 Shipley
62	Goldendale Iron Co., Ltd.	Tunstall, Stoke-on-Trent	Goldendale, Tunstall, Staffs	—
68	Gray, Thomas, E., & Co.	71, Lincolns Inn Fields, Kingsway, London, W.C.	Papplewick, London	1193 City
118	Hall, John, & Co (Stourbridge), Ltd.	Fire Clay Works, Stourbridge	Hall, Stourbridge	55 Stourbridge
68	Hislop, R. & G.	Paisley	Gas, Paisley	331 Paisley
69	Keith, James & Blackman, Co., Ltd.	27, Farringdon Avenue, London	James Keith, London	6194 H'lb'rn(4lines
64	King, Bros. (Stourbridge), Ltd.	Stourbridge	King Bros., Stourbridge	—
73	Kuhnle, Kopp & Kausch	Frankenthal-Pfalz, Germany	—	—
122	London Emery Works, Co., Ltd	Park, Tottenham	Naxium, London	99 Tottenham
120	Lowood, J. Grayson, & Co., Ltd.	Deepcar, nr. Sheffield	Lowood, nr. Sheffield	18 Stocksbridge
68	Marshall, H. P., & Co.	Leeds	Specialty, Leeds	1909 Leeds
	Metalline Cement Co.	112, Bath Street, Glasgow	Adhesive, Glasgow	201Y2 Douglas
67	McLain's System	710, Goldsmith Bldg, Milwaukee, U.S.A.	—	—
124	McNeil, Chas.	Kinning Park, Glasgow	McNeil, Glasgow	X 155
69	Murphy, Stedman & Co. Ltd	180, Gray's Inn Road, London, W.C.	—	—
123	Naish & Croft	141, Whitehead Road, Aston Manor	—	—
	National Time Recorder Co.	5, Blackfriars Road, London, S.E.	Natrecord, London	918 Hop
64	Olsen, William	Cogan Street, Hull	Wm. Olsen, Hull	Nat. 1184
	Pattern Requisites, Ltd.	24, Branstone Street, Birmingham	—	—
120	Phillips, Charles D	Newport, Mon.	Machinery, Newport	—
C. iii	Phillips, J. W. & C. J.	23, College Hill, E.C.	Colloquial, London	10112 Central
72	Pickles, James, Ltd.	Laurel St., Leeds Rd., Bradford	Pickles, Laisterdyke	3723 Bradford
66	Piftin, Ltd.	2, Fen Court, Fenchurch Street, E.C.	Russesco, London	11230 Central
	Rapid Magnetting Machine Co., Ltd.	18, The Crescent, Birmingham	Borings, Birmingham	Central 1842
120	Rudd & Owen	Hull	Therpinene, Hull	1223 Nat.
71	Samuelson & Co., Ltd.	Banbury	Samuelson, Banbury	—
61	Standard Sand Co., Ltd.	Mansfield	Standard Sand Co., Mansfield	201 Mansfield
65	Stewart, D., & Co., Ltd.	London Road Iron Works, Glasgow	Stewart, Glasgow	71 P.O. Bridgton & 3243 Bridgton (N)
C. iii.	Tilghman's Patent Sand Blast Co., Ltd.	Broadheath, nr. Manchester	Tilghmans, Altrincham	14
70	Thwaites Bros., Ltd.	Bradford	Thwaites, Bradford	3459&3460 Br'df'rd
65	Walker, I. & I.	Rotherham	—	—
124	Walton & Co.	53, Newton Street, Birmingham	"Walco," Birmingham	Central 3305
124	Whittaker, W., & Sons, Ltd.	Oldham	Whittakers Engineers, Oldham	83
73	Wilkinson, Thos., & Co., Ltd.	Middlesbrough	Blacking, Middlesbro'	419
73	Witting Bros., Ltd.	49, Cannon Street, London, E.C.	Witting, Cent., London	8776 & 8777 City

MANSFIELD MOULDING SAND.

Our "SPECIAL" brand as Shipped and Supplied only by us to all parts of the World, for Castings of Iron, Brass, Aluminium, &c. Needs no Grinding or Milling, and is ready for the Moulder.

WRITE STATING CLASS OF WORK TO

The Standard Sand Co., Ltd.,

Mansfield, NOTTS.

Goldendale Cylinder Pig Iron.

MAKERS:

GOLDENDALE IRON Co.,

TUNSTALL, STOKE-ON-TRENT.

Special FOR GAS AND OIL ENGINE LINERS - -

Our Mottled and White .. Cylinder Pig Irons ..

ARE

Absolutely sound and homogeneous

AND

Melt hot and Fluid.

AND

Though extremely hard will machine with ease

AND

Will Cool like Grey Iron leaving no cavity.

CONTRACTORS TO THE ADMIRALTY, COLONIAL GOVERNMENTS, AND OTHER GOVERNMENT CONTRACTORS.

Selling Agents—

WESTOBY & RAWSTRON, 224, Corn Exchange Buildings, Hanging Ditch, Manchester.

Most Ironfounders are by this time aware of the existence of the Osborn Patent Spark Arrester in connection with Foundry Cupolas, but there are many who do not know that this appliance **gives complete immunity from the spark nuisance.**

Its adoption has invariably proved successful, although, in many cases, it has **taken the place of other types of spark arresters** which have failed.

It not only avoids damage to roofs, choking of gutters, and danger of fire, but, **it is an important labour saver**, as it not only effectually arrests the sparks and grit, but **conducts these down to, or through the charging platform**, where they can be dropped into a cart or truck **without any handling whatever;** this is **an advantage not possessed by any other spark arrester yet introduced.**

It is constructed in sections, with external bolted flanges, to facilitate erection.

For further Particulars apply to the Sole Licensees and Makers:

T. DAVIES & SON,

Railway Works, West Gorton, MANCHESTER.

Specialities—

FOUNDRY CUPOLAS & LADLES

London Agents: Murphy, Stedman & Co., Ltd., 180, Gray's Inn Road, London, W.C.

FIRE BRICKS & CLAY.

CUPOLA BRICKS.

BEST QUALITY.

LESSEES OF DELPH AND TINTERN ABBEY BLACK AND WHITE CLAY.

KING BROTHERS,

(STOURBRIDGE) Ltd.,

STOURBRIDGE.

PLUMBAGO — CRUCIBLES.

Parting Powder.

MATERIALS & REQUISITES FOR IRON & BRASS FOUNDRIES

Wm. OLSEN M.B.F.A.

74, COGAN ST., HULL.

CATALOGUE ON APPLICATION.

Wax Core Vent.

GLUTRIN — CORE GUM.

WILLIAM CUMMING & CO., LTD.,

FOR IRONFOUNDERS' BLACKING
PLUMBAGO
BLACK LEAD
CORE GUM
COAL DUST
ETC.

—o—

Write for Quotations.

WORKS—
Kelvinvale Mills, Maryhill, Glasgow
Sunnyside Blacking Mills, Falkirk.
Old Packet Wharf, Middlesbrough.
Albion, West Bromwich.
Whittington Blacking Mills, Nr. Chesterfield.

IRONFOUNDERS FURNISHERS
Established 1840.

Also
THE WELL-KNOWN BRANDS
"IMPERIAL"
"EUREKA"
"VULCAN"
"CROWN"

Registered Brand—
"SHALAGO"

Telegraphic Address—
Prudence, Glasgow.
Cummin Blacking Mills, Cameion.
Cumming, Whittington, Chesterfield.

T. & I. BRADLEY & SONS, LTD.,

COLD BLAST PIG IRON

PIG IRON BRANDS

PART MINE. WARM AND COLD BLAST. I X L. ALL MINE. A M

TO GUARANTEED ANALYSIS.

DARLASTON BLAST FURNACES,

DARLASTON, SOUTH STAFFS.

Proved ALUMINIUM Alloys

No. 6. For Clean Castings, easily machined.

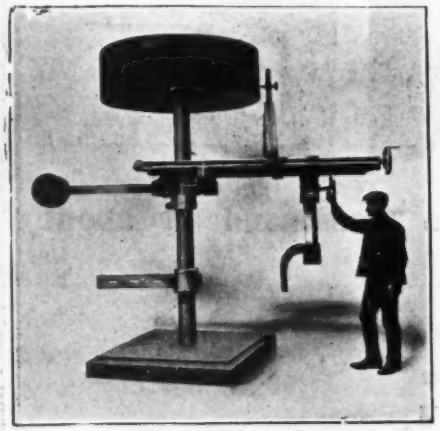
No. 6a. Stronger than No. 6, but not so tough.

No. 4. For All-round work, malleable.

Trade Mark.

Write for prices, and "Foundry" Leaflet:

THE BRITISH ALUMINIUM CO., LTD., Ad. Dept., 109, Queen Victoria Street, LONDON.



Standard Wheel Moulding Machine.

ALL IRON AND STEEL FOUNDRIES

SHOULD BE EQUIPPED WITH

STEWART WHEEL MOULDING MACHINES.

Complete Satisfaction Guaranteed

* *

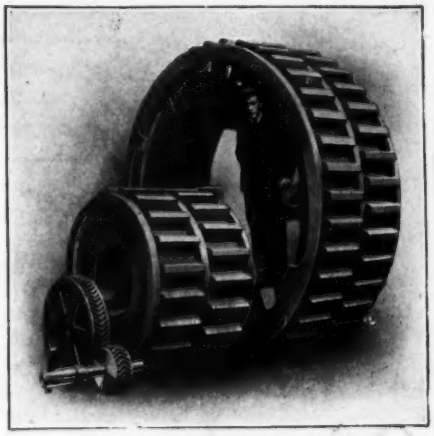
No Loose Parts Liable to be Lost.

ACCURATE. PORTABLE. CHEAP.

WRITE FOR PRICE AND PARTICULARS TO

DUNCAN STEWART & CO., LTD.

LONDON ROAD IRONWORKS, GLASGOW.



Wheels Moulded by this Machine.

WE SUPPLY **THE** LEADING FIRMS IN THE TRADE WITH

FOUNDRY BLACKINGS

OF ALL KINDS,

COAL DUST, CHARCOAL, PLUMBAGO and BLACK-LEAD, CORE GUMS and all Foundry Requisites, and have done so since 1831.

I. & I. WALKER, EFFINGHAM MILLS, ROTHERHAM.

Our Specialite is Studying Special Requirements.

KINDLY HAND US YOUR ENQUIRIES.

PIFTIN

System of Renovating Foundry

SAND

will give you sand at about

1/5th

THE COST

Of what you now Pay.

For full particulars apply— Telegrams: "RUSSESCO, LONDON." — Telephone: No. 11230 CENTRAL.

PIFTIN LIMITED.

2, FEN COURT, FENCHURCH STREET, LONDON, E.C.

Why play with a little steel in the ladle when you can use 50°/₀ in the cupola?

Foundrymen have long recognised the value of steel additions to their mixtures.

But many of those same foundrymen have repeatedly lost big sums of money in experimenting.

They stick a steel rod into the ladle of molten iron, or throw a few shovelfuls of turnings into the cupola. Improvement noted right away. Maybe you have too.

Then they try a little more—get into trouble—condemn it—HAVE YOU?

You have merely been playing with a little steel—2 to 5°/₀. Follow McLain's system and use 20 to 50°/₀—10 times more.

What are the results? A thousand students in all parts of the world say, "AMAZING."

Gears made of McLain's Semi-Steel outwear all steel gears.

Draws or soft spots at intersection of light and heavy sections absolutely prevented.

Pistons made 3.32 of an inch thick containing 20% steel—would never stand up in this section made of grey iron.

Foundrymen make Semi-Steel cylinders that require scarcely any lubricant. WHY? Because adding steel by McLain's instructions gives a high graphitic carbon which acts as a lubricant on wearing surfaces.

Transverse jumps from 2,200 to 2,400 up to 4,400, and tensile goes to 42,000 lbs. and over.

Mixtures cost less because you save on high priced hematite or other expensive pig.

Castings are free from blow holes, hard spots, sponginess or segregation.

Losses cut to 2 to 3 per cent.

No metal made in the cupola equals McLain's Semi-steel for strength, wear and cheapness of cost.

You can improve hundreds of your castings and save money besides.

No guessing—no Experimenting—no New Equipment Necessary.

Additional Information FREE. Mail Coupon NOW.

McLAIN'S SYSTEM, 710, Goldsmith Bldg., Milwaukee, Wis., U.S.A.

Send additional information and 24 page "Synopsis" free.

Name .....

Position .....

Firm .....

Address .....

2/14.

WRITE

THOS. E. GRAY & Co.,

Contractors to H.M. War Office,

71, LINCOLNS INN FIELDS, KINGSWAY, LONDON, W.C.

Telegrams—"Papplewick, London."
Telephone—1193 City.

BUY IN THE CHEAPEST MARKET.

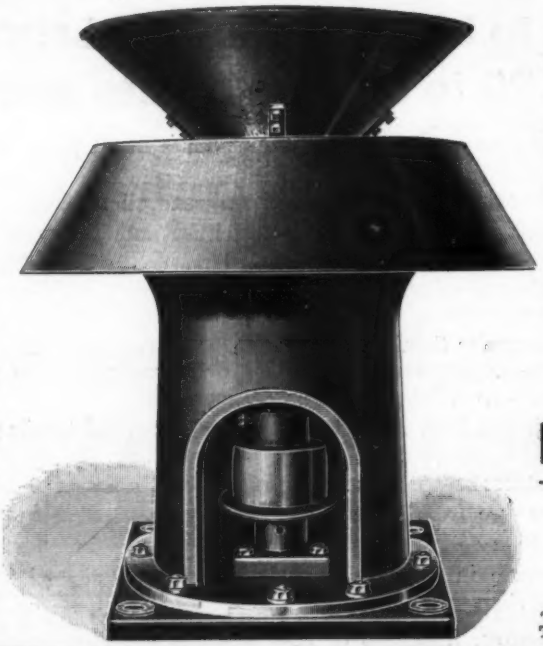
LOWEST PRICES FOR—

Best Washed Welsh Foundry Coke.
Best Durham Foundry Coke.
Special Brass Foundry Coke.
Best Quality Ground Ganister.
Nottinghamshire Red Sands.
Rolled Sand and Facing Loam.
Pure Plumbago.
Limestone.
Smith's Breeze.

Best Large Lancashire Foundry Coke.
Best Yorkshire Steel Coke.
Derbyshire Foundry Coke.
Worcestershire Red Sands.
Superfine French & Belgian Sands (unequalled for Brass & Aluminium).
Coal Dust.
Anthracite, Steam and House Coal.
Smokeless Welsh Steam Wagon Coal.

The "Leeds" Centrifugal Sand Mixer.

Ensures
GREAT ECONOMY
of
LABOUR.



This machine thoroughly mixes and disintegrates sand, delivers it in a porous condition, and thus ensures smooth castings.

Made in two sizes and arranged for overhead or self-contained electric drive.

One H.P. required for every two tons of sand per hour.

We also supply:—
COKE BREAKERS,
CUPOLAS,
CORE MACHINES,
Rotary and piston type.
MOULDING MACHINES
of various types.
SAND MILLS,
MOULD DRIERS,
TUMBLING BARRELS,
Etc., Etc.

HORACE P. MARSHALL & CO.,

Foundry Specialists,

LEEDS.

Telegrams: "Specialty, Leeds,"
Telephone No 1909.

EFFICIENT AND ECONOMICAL HEATING OF FOUNDRY STOVES, ANNEALING OVENS, FURNACES, &c.

R. & G. HISLOP,

Gas Engineers, Underwood House, PAISLEY.

KEITH-BLACKMAN SMITHY PLANTS.

The illustration shows a range of "Keith-Blackman" Smith's Hearths, the Blast to same being served by two "K-B" High Pressure Fans, a "Keith" Centrifugal Fan for Smoke Removal, and Piping.

We have installed a large number of Plants, and we invite you to make use of our wide experience.

JAMES KEITH & BLACKMAN CO., LTD.,

27, Farringdon Avenue, LONDON.

CORE OVENS & - - DRYING STOVES.

The latest and most satisfactory types on the market.

The door handles are on either end of the door and *never* get hot.

The door can be opened or closed with one hand. No hasps, catches, buttons or fasteners of any description.

No escape of heat when the door is opened.

Made in all sizes with any number of shelves, at strictly competitive prices.

Please write for our Furnace List for the latest practice in melting plant and heating apparatus.

MURPHY, STEDMAN & CO., LTD.,

180, Gray's Inn Road, London, W.C.

FOUNDRY PLANT.

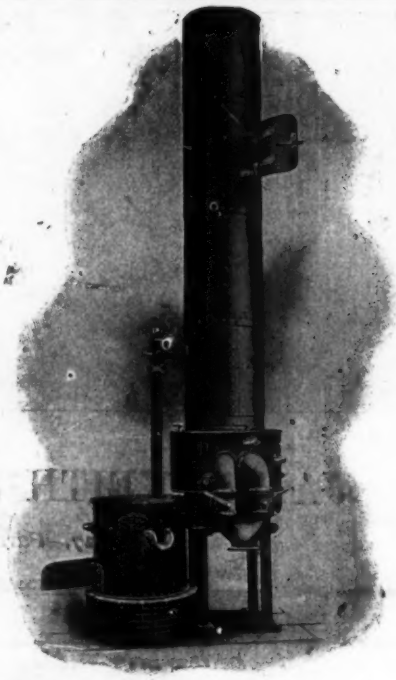
"Rapid" Cupolas,

with or without receivers or drop bottoms.

Roots' Blowers,

belt, steam-engine, or electro-motor driven.

Charging Platforms, Hoists, and Ladles.



ECONOMICAL RESULTS GUARANTEED.

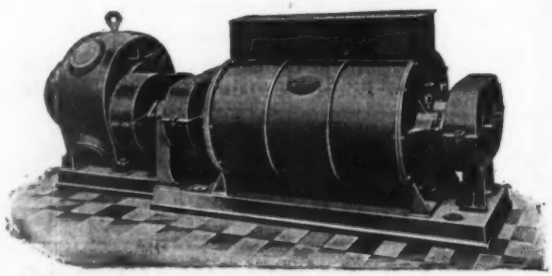
We are also Manufacturers of Steam Hammers, Smiths' Hearths, Centrifugal Pumps and Fans, High-Speed Engines, and the "Bradford" Patent Boiler Feed Pump.

We are the original makers of "Rapid" Cupolas as under Stewart's Patent. We make this intimation as other makers are introducing this description, which had become established as a synonym of Stewart's Cupolas.

CONTRACTORS TO HIS MAJESTY'S GOVERNMENT.

THWAITES BROS., LTD.,

Vulcan Ironworks, BRADFORD.



Telegrams—
"THWAITES, BRADFORD."

Telephone—
Nos. 3459 and 3460 BRADFORD.

London Office:
96 & 98, Leadenhall Street, E.C.

Catalogues on Application.

IMPORTANT TO IRONFOUNDERS.

MOULDING— —MACHINES

FOR REPETITION FOUNDRY WORK.

Illustration of

HAND PRESS MACHINE

for Small Repetition Work, giving rapid and Economical Production.

Makers also of a

HAND RAMMING MACHINE

where a Deep Lift is required. Can be Operated by

UNSKILLED LABOUR.

MOST EFFICIENT AND ECONOMICAL IN USE.

Also Makers - - of - - ROOTS' "ACME" BLOWERS.

FULL PARTICULARS FROM—

Samuelson & Co., Ltd., Banbury,

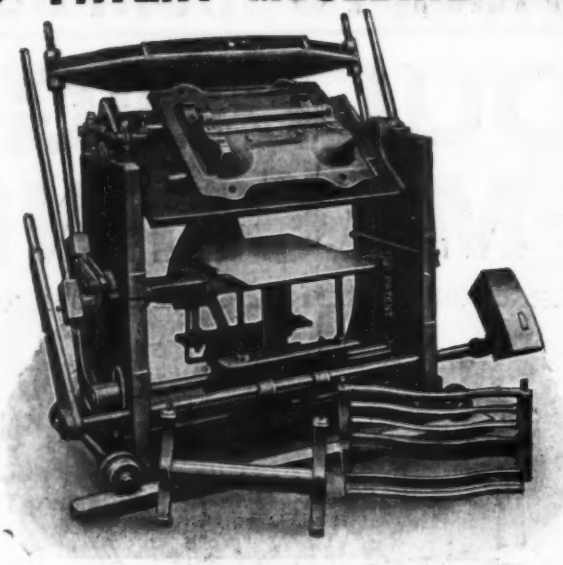
ENGLAND.

SEE OUR ADVERTISEMENT EVERY ALTERNATE MONTH.

PICKLES' PATENT MOULDING MACHINES.

The Best and Quickest Hand Machine made.

They are made to any size and to suit existing Plates & Boxes.



Standard . . . Machines sent on approval to any responsible firm.

Strong and durable, easy to work.

Write for Catalogues to

JAMES PICKLES, LTD., Victoria Works, BRADFORD.

Telegrams: PICKLES, LAISTERDYKE. Phone: 3723

A NEW STEEL BARROW

(PATENTED)

"BRABY'S BALANCED BARROW."

The Handiest and Cheapest Barrow in the market. Specially designed for coal, dross, ashes, etc. Its capacity is **25 per cent. greater** than the ordinary style, yet it can be wheeled with **half the labour**, and can be emptied **much more quickly**. It is a **perfectly balanced** barrow, and a full load can be **easily wheeled by a boy.**

NOTE.—This Barrow can be taken right up to mouth of furnace and the ashes drawn into the barrow direct from the furnace.

The "B.B.B."

BRABY for high grade **STEEL**
SHEETS & PLATES up to 15 FEET LONG.
RANGE of GAUGES 8 to 30 W.G.
RANGE of WIDTHS 12 to 60 in.

BRABY for improved wrought **STEEL**
BARROWS. BOGIES, TRUCKS.
GUTTERS. PIPES, &c.

BRABY for Iron and **STEEL**
ROOFS and BUILDINGS.

BRABY for unbreakable **STEEL**
SASHES, CASEMENTS, and PUTTYLESS ROOFLIGHTS.

BRABY for galvanized corrugated **STEEL**
SHEETS: "EMPRESS" & "SUN" BRANDS

FREDERICK BRABY & Co. Ltd., Eclipse Iron & Galvanising Works & Steel Sheet Rolling Mills, Petershill Road, GLASGOW.

Show Rooms and Aluminium Warehouse, 124, St. Vincent Street, Glasgow.
Rustless Iron, Galvanising and Copper Works, FALKIRK.

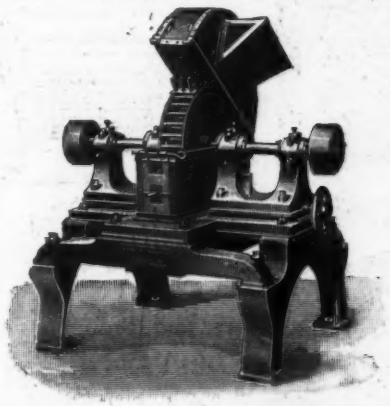
Also at London, Deptford, Liverpool, Bristol, Belfast and Dublin. CONTRACTORS to BRITISH and FOREIGN GOVERNMENTS. Teleg.—"Braby, Glasgow."

FOUNDRY PLANT.

SAND MIXERS. ROLL MILLS.
DISINTEGRATORS.

BRINCK & HÜBNER,
Mannheim, Germany.

Agents - D. MAAS & Co.,
49, Old Broad Street, LONDON, E.C.



"Binderit" Wireless

WIRELESS.

This core (one-half of a piston-valve steam-chest core) was formed entirely without wires, only a centre bearer being used. The sand used was:—2 sharp sand, 2 foundry floor sand, 1 loam, tempered with **BINDERIT.**

BINDERIT is a soluble water binder; it is a substitute for oil and oil-compounds, but is **50% to 75% CHEAPER.**

Have you tried it? If not, let us send you a sample **FREE.** You can then prove its efficiency and great economy.

THE BRITISH BINDERIT CO., LTD.,
Southampton House, 317, High Holborn, W.C.

Telephone—Holborn 950.
Telegrams—"Bindercomp, Holb., London."

BLACKING
PLUMBAGO
COAL DUST
CHAPLETS
STRAW ROPES
CORE GUM &c.

Agents for
"GLUTRIN."

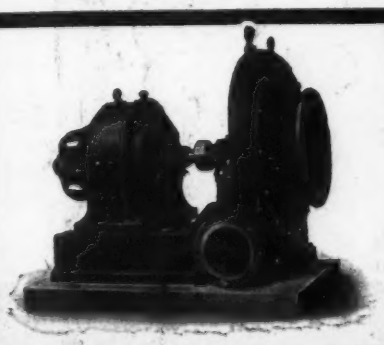
FOUNDRY STORES

Can ship cheaply to chief Ports on East, South and Welsh Coasts, also to Belfast.

THOMAS WILKINSON & Co., Ltd.,
MIDDLESBROUGH.

FRENCH RED MOULDING SAND AND SILVER SAND.

THAMES LOAM AND LOCAL SAND.



Aktiengesellschaft Kühnle, Kopp & Kausch Frankenthal-Pfalz.

TURBO
BLOWERS,
COMPRESSORS,
VENTILATORS.

Represented by **WITTING BROS., LTD., LONDON, E.C.,** 49, Cannon Street.

COMPLETE

Foundry Equipment.

Telegrams: "LADLES" MANCHESTER
Telephone: "No 2297 CENTRAL" MANCHESTER.

JAMES EVANS & Co. BRITANNIA WORKS, BLACKFRIARS. MANCHESTER.